U.S. NAVY

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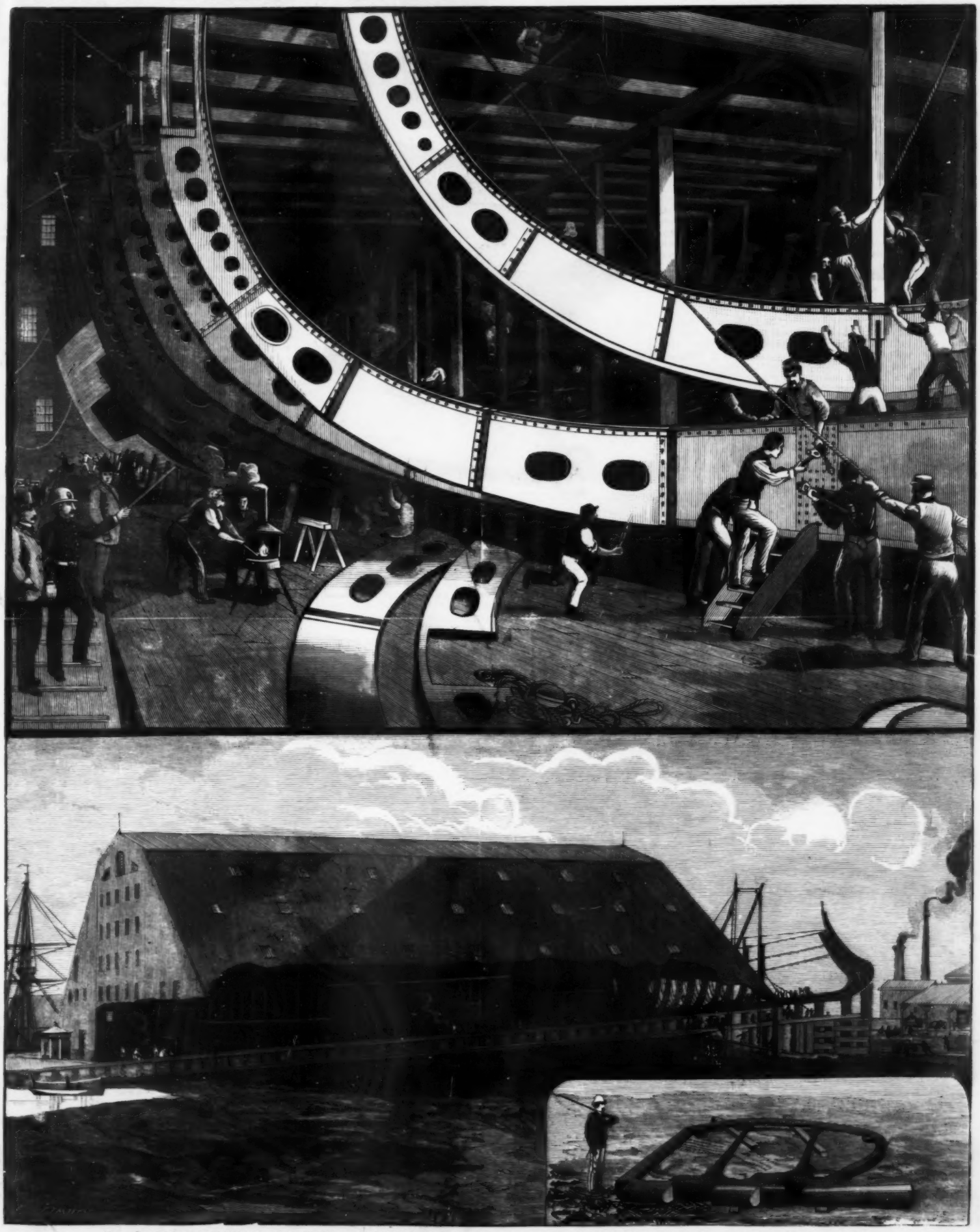


FIG. 1.—CONSTRUCTION OF THE BATTLESHIP "MAINE," AT THE BROOKLYN NAVY YARD, NEW YORK.

THE BATTLESHIP "MAINE," 1886–1898.

THE terrible catastrophe to the battleship "Maine" in Havana Harbor on the evening of February 15, 1898, resulted in the death of 260 of our brave sailors, plunged the whole country into gloom and resulted in bringing the Cuban question to an issue. We propose to briefly describe the battleship "Maine," including its construction and destruction.

The battleship "Maine" was originally built as an armored cruiser. It was authorized by the Navy Act of August 3, 1886. Our engraving (Fig. 1) shows the construction of the vessel at the Brooklyn Navy Yard. The "Maine" was built throughout of steel. Her length over all was 324 feet 4¼ inches; on load water line, 318 feet 3 inches; her extreme beam was 57 feet. Her mean draft was 21 feet 6 inches, and her displacement 6,682 tons. She had a protective belt of nickel steel armor 12 inches thick for a distance of 180 feet of her length on each side, covering her machinery and vital parts. The bottom was double, with numerous watertight divisions, and she had a protective deck 2 inches thick amidships and 4 inches thick on sloping parts. She was designed to have a speed of 17 knots, and her coal-carrying capacity was rated as sufficient for 7,000 knots of steaming. The engines were built by Messrs. N. F. Palmer, Jr. & Co., New York City, N.Y., and were of the vertical inverted cylinder triple-expansion type; the cylinders were 35½, 57 and 88 inches in diameter and the stroke was 36 inches. There were two engines actuating two three-bladed screws of a diameter of 15 feet, at 132 revolutions. The engines were designed to give about 9,000 indicated horse power. There were eight steel boilers, 14 feet 8 inches by 10 feet, designed to work at a pressure of 135 lb. The pumps were of the Blake type and supplied hydraulic power for a variety of purposes.

The battery of the "Maine" consisted of four 10-inch rifled guns mounted on two turrets, one forward on the starboard side and one aft on the port side. These guns were protected by the 12-inch armor of the turrets and by 8-inch shields. The auxiliary battery consisted of six 6-inch breech loading rifles on the battery deck, protected by 2-inch shields, and there was a secondary battery of seven 6-pounder rapid-fire and eight 1-pounder rapid-fire guns. There were seven torpedo tubes with a range around the entire horizon. Her cost was placed at $2,500,000.

The following are the dates in the history of the construction of the "Maine" from the time she was authorized until she was launched: She was built under an act of Congress approved August 3, 1886, and was designed by the Navy Department. Plans approved June 4, 1888. Contract for materials opened June 4, 1888. Contract for materials signed June 15, 1888, with Messrs. Carnegie, Phipps & Co., Pittsburg, Pa. First frame bent September 10, 1888. First keel plate laid October 11, 1888. First rivet driven November 2, 1888, 11 o'clock A. M. First frame raised December 5, 1888. Vessel launched November 18, 1890.

Our engraving shows the frames as they were secured in position in the mammoth shed at the Brooklyn Navy Yard, where the work was in progress. This shed was erected during the civil war and was situated near the ferry to the Cob dock. The shed was not large enough to contain the "Maine," and the prow of the boat extended into the open.

As soon as the keel plates of the "Maine" arrived at the yard, the work was begun of laying the keel.

The plates were laid in an unbroken line from stem to stern, some of them being flat, some vertical; 40 feet deep in the midship section, and 35 where free from the second hull, the keel line being scarfed at the sternpost and the forefoot. After the keel was laid the transverse frames were raised—lowered would be a better term, as they are slung from cranes, each frame being in two parts, because of the weight and unwieldiness. There were eighty-four of these below the protective deck, made of angle bar 5 by 3 inches and weighing 10 pounds per foot, the reverse bars

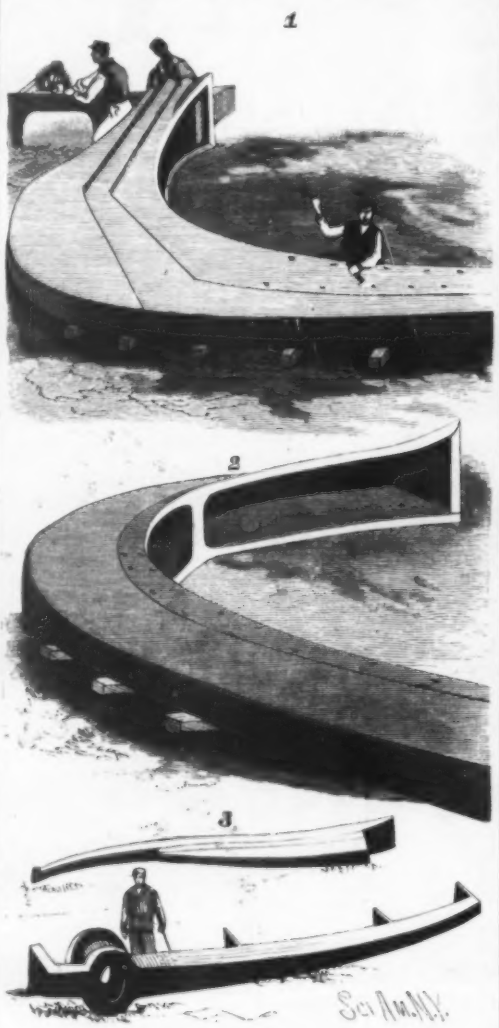


FIG. 2.—CASTINGS FOR RAM BOW AND STERNPOST OF THE "MAINE."

being 4 by 4 inches. They were braced by longitudinal frames extending also between the protective deck and the keel blocks, the weight and strength of these being increased forward and abaft the double bottom. The longitudinal frames run uninterruptedly from stem to stern, and were designed and set with the purpose of supporting the shock of ramming as well as keeping the structure intact.

It was found necessary to erect a house in the yard in which to store the various parts of the "Maine" as they arrived from the steel works. This house was called the plate rack, and was 191 feet long by 31 wide. In it the plates for the hull were laid out or set up on end in regular order and numbered so that a master workman could tell at a glance where each belonged. The contract with the steel works in Pennsylvania where the work was done called simply for so many pieces of this or that size or shape. The contours, bends, curves, and rivet-holing were all done in the navy yard shops. The frames or plates as they were needed were first shaped so as to exactly correspond with patterns that had been made in the moulding loft. These patterns were made of thin strips of wood affixed together so as to follow the exact lines of each piece. A plate, for example, first went to the roller shop, where it was smoothed out between the two great iron rollers, being passed backward and forward and given its proper inclination, thence to the punching shop, where it was punched for riveting on the hull, also a work of great care, for unless the holes be exactly in place they will not correspond with their mates in the frames. At last comes the operation of countersinking, taking off the bulging edge about the holes and countersinking the orifices to receive the heads of the rivets. The frames were first taken to the furnace house and the forge, being then hurried upon the bending slabs, a great raised flooring of heavy steel plates perforated with holes. The shape desired having already been laid out in chalk, the piece was bent to the proper shape by means of pries and levers in the hands of the workmen; one putting in a pin here to keep the curve secured, and others pressing and tugging away to bend still more. Thus, when at last a piece arrived at the shed, the workmen had only to raise it and drive the rivets home through the corresponding holes in plate and frame, the foreman having shown them by reference to his drawings exactly how it is to fit.

A feature of the work on the "Maine" was the use of electricity for power and putting the parts of the boat together. It is said this was the first time in the history of shipbuilding in which electricity was employed. The "Maine" had two bottoms or skins braced stoutly one over the other, so that in case she struck upon a rock and the under hull or skin was ruptured, the only effect would be to admit the water between the two hulls and give her a lower set in the water from the loss of buoyancy, but remain staunch and seaworthy. It was said at the time she was building that the double hulls would not save her if she ran upon a torpedo properly placed, and her recent destruction in Havana Harbor confirms this opinion, but, of course, the double hull is not intended to stand any such test.

Her bow sheered into a formidable ram just below the water line, the stern coming inboard so that there was nothing above the water to indicate that she possessed a sternpost or a rudder, for the latter was deeply submerged. Both stem and sternposts were of steel, rabbeted for the bottom plating to get a stout inset and powerful clamping. The under end was scarfed to the plates of the keel with canting frames strengthened to increase the backing of the ram. The rudder, a ponderous piece of steel, is shown as an inset in one of our large engravings (Fig. 1), and the sternpost and its lever in Fig. 2.

The "Maine" was launched before her engines or boilers were placed in position or her armor was secured to the hull.

The launching on Tuesday, November 18, 1890, was a notable event in the history of New York, and it at-

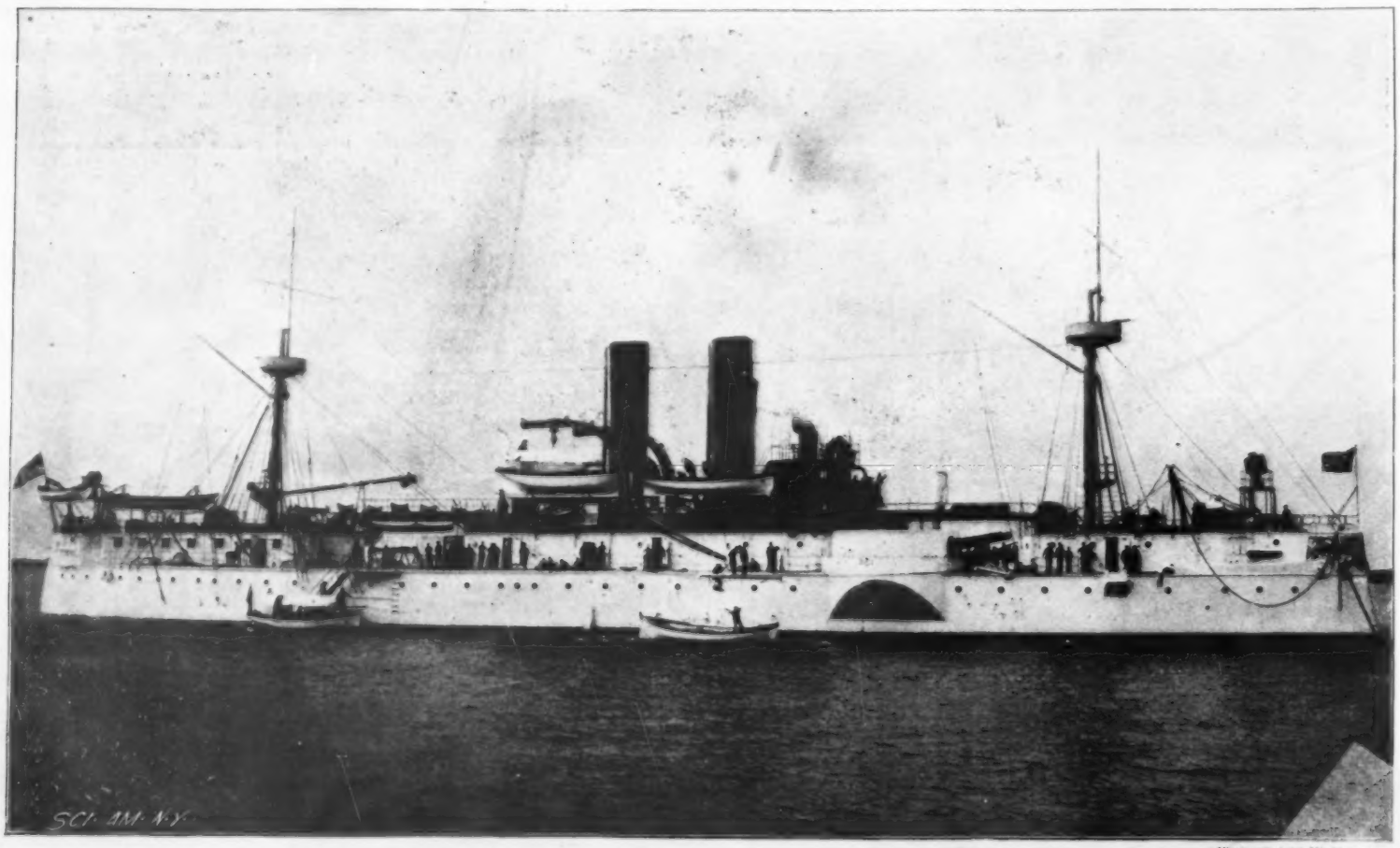


FIG. 3.—THE UNITED STATES BATTLESHIP "MAINE," SUNK IN HAVANA HARBOR, FEBRUARY 15, 1898.

Photograph by W. H. [illegible]

tracted a large number of people from New York, Boston, Philadelphia and Washington, and from more distant points. The arrangements for the spectators were very complete. A large number of stands were erected around the boat, and on either side of the ram was a launching platform which held many representatives of the press. Upon this platform a small stand was erected for the Secretary of the Navy, the commandant of the yard and some especially invited guests. The breaking of the traditional bottle of champagne and the christening of the vessel was intrusted to Miss Alice Tracy Wilmerding, a granddaughter of Secretary Tracy. The champagne was made from grapes grown in San Bernardino County, California.

The hour of the launch was about 12:45 P. M. As she passed down the ways a workman wrote the name "Maine" on her bows.

The armor belt was made up of solid steel pieces, 12 inches thick, the first tier resting upon what is called the armor shelf, which will be seen by reference to Fig. 4 immediately a-top the girders where the perforated beams end. These slabs of the armor belt were backed by about four feet of solid oak and, at certain points, were further supported by enormous coal bunkers.

The battleship "Maine" was sent to Havana Harbor for a "friendly visit," and was received with seeming hospitality. She was anchored in a place expressly selected and designated by the Spanish authorities. She was kept in the best of order internally, and every possible precaution was taken for the safety of those on board. On Tuesday evening, February 15, 1898, after the usual inspection of the ship had been made and the crew had swung into their hammocks for the night, suddenly, and without preliminary warning, the "Maine" was torn open by an explosion which sent her quickly to the bottom, causing the death of 260 out of her complement of 354 officers and men. The fatalities were confined almost entirely to the crew, owing to the fact that the explosion occurred under the berth deck in the forward half of the ship, the officers' quarters being in after end of the ship. Lieut. Blandin gives a graphic account of the disaster, from which we quote as follows:

"Scarcely had I spoken when there came a dull, sullen roar. Would to God that I could blot out the sound and the scenes that followed! Then came a

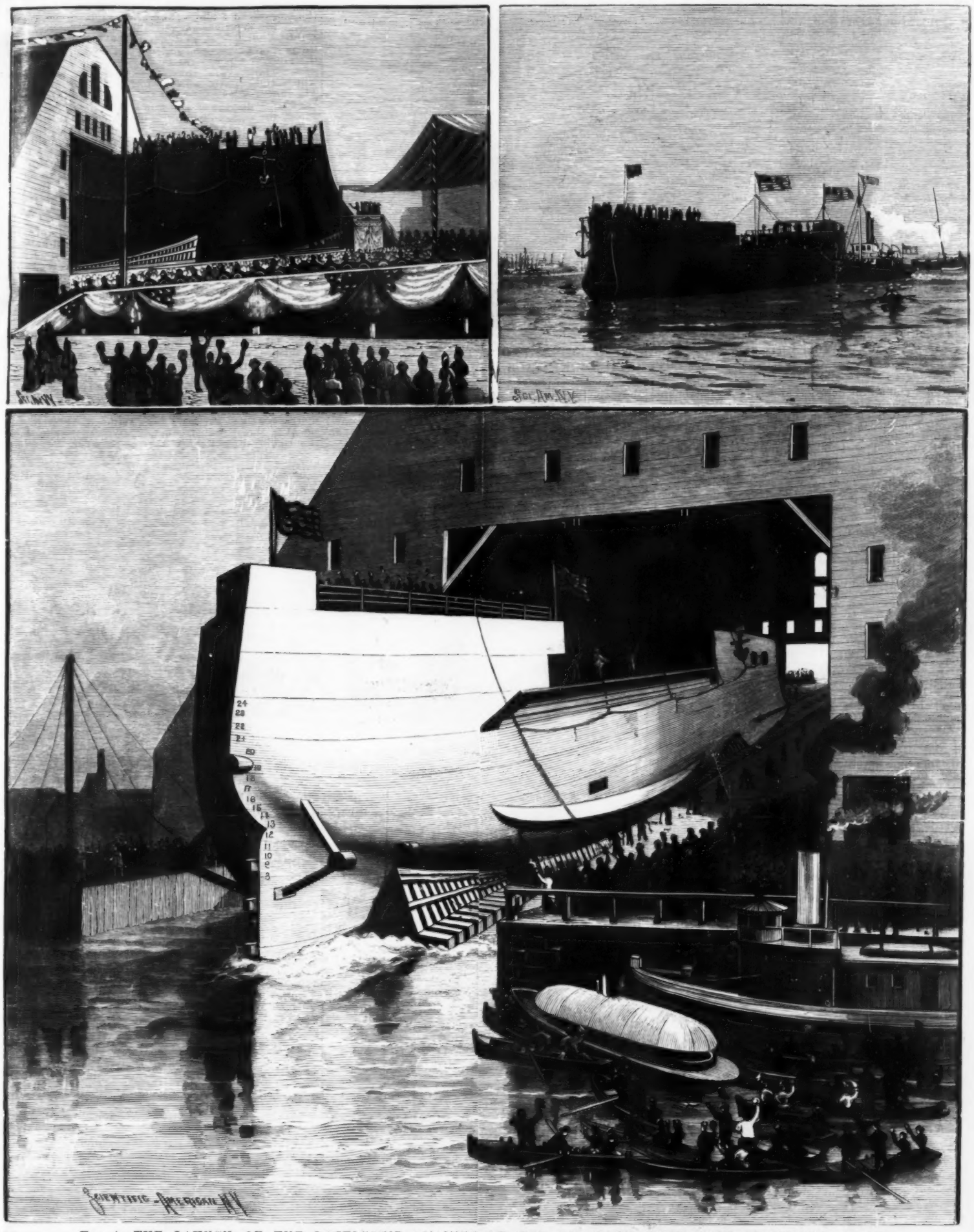


FIG. 4.—THE LAUNCH OF THE BATTLESHIP "MAINE" AT THE BROOKLYN NAVY YARD, NOVEMBER 18, 1890.

sharp explosion; some say numerous detonations. I remember only one. It seemed to me that the sound came from the port side forward. Then came a perfect rain of missiles of all descriptions, from huge pieces of cement to blocks of wood, steel railings, fragments of

FIG. 5.—PORT SIDE OF WRECK, SHOWING SUPERSTRUCTURE, DECK RUINS AND OVERTURNED SMOKESTACK.

gratings, and all the debris that would be detachable in an explosion.

"I was struck on the head by a piece of cement and knocked down; but I was not hurt, and got to my feet in a moment. Lieut. Hood had run to the poop; and I supposed, as I followed, he was dazed by the shock and about to jump overboard. I hailed him, and he answered that he had run to the poop to help lower the boats.

"When I got there, though scarcely a minute could have elapsed, I had to wade in water to my knees, and almost instantly the quarter deck was awash. On the poop I found Capt. Sigsbee as cool as if at a ball, and soon all the officers, except Jenkins and Merritt, joined us. The poop was above water after the 'Maine' settled to the bottom. Capt. Sigsbee ordered the launch and gig lowered, and the officers and men, who by this time had assembled, got the boats out and rescued a number in the water. Capt. Sigsbee ordered Lieut.-Commander Wainwright forward to see the extent of the damage, and if anything could be done to rescue those forward or to extinguish the flames, which followed close upon the explosion and burned fiercely as long as there were any combustibles above water to feed them.

"Lieut.-Commander Wainwright, on his return, reported the total and awful character of the calamity, and Capt. Sigsbee gave the last sad order, 'Abandon ship!' to men overwhelmed with grief, indeed, but calm and apparently unexcited."

According to the testimony of a passenger upon the "City of Washington," there were two distinct explosions, the interval between them being sufficient to give him time to run up on deck and witness the falling debris of the wreck. The ship took fire at once, and was so badly shattered and went down so swiftly that some of the survivors had barely time to climb through the hatchways and escape being drowned between decks. Boats were immediately lowered from the "City of Washington" and from the Spanish cruiser, and these succeeded in picking up a large number of the survivors. A dramatic incident occurred when an officer of the "Maine," in one of the rescuing boats, called out: "If there is any one living on board, for God's sake say so!" The only answer was an echo from the distant shore, which repeated "for God's sake." Then occurred an anxious period of waiting while the matter was being investigated with remarkable thoroughness by the Marix court martial, and efforts were made to raise the "Maine," Congress having made an appropriation for this purpose. It was not found possible to accomplish this, and the wrecking companies who had proceeded to Havana were obliged to come away without doing more than raise some of the guns. Our engravings, Figs. 5 to 10, show the terrific effects of the explosion. They were made from a set of photographs furnished by our special correspondent in Havana.

"The Report of the Naval Court of Inquiry upon the Destruction of the Battleship 'Maine' in Havana Harbor" is a volume of 300 pages, and includes all of the testimony given before the court. At the end of the report there are some two dozen photographs and drawings illustrative and descriptive of the wreck. It is one of the most remarkable documents which has ever been issued by the Government Printing Office. We take pleasure in giving an account of the testimony and findings of the report and reproduce several of the drawings. It tells its horrible story with too much distinctness to require much comment by way of explanation. One does not have to read far in this extraordinary report before the last charitable hope which one may have had that the wreck was not a crime but an accident is shut out and one is forced to the conclusion that a submarine mine of enormous power was exploded beneath the ill-fated battleship.

In the half section and plan of the "Maine" (Fig. 11) the normal and proper position of the keel and bow of the ship as she rode at anchor are shown in fine, unbroken lines. The thick lines show the shape into which these parts were distorted by the explosion. The bow it will be seen was twisted around through an angle of 90 degrees and now lies at right angles to the axis of the ship. The ship is blown completely in two a little forward of amidships, and forward of that, at frame 18, the keel has been blown up into an acute inverted V until it is near the surface of the water, or 30 feet above its normal position. These effects are shown in the drawing (Fig. 14) prepared by Ensign Powelson from the reports of the divers and from his own personal investigation. A more detailed view of this point, marked 1 A in Fig. 11, is shown in Fig. 13.

We give below the full findings of the court:

1. That the United States battleship "Maine" arrived in the harbor of Havana, Cuba, on January 25, 1898, and was taken to buoy 4, in from five and a half to six fathoms of water, by the regular government pilot. The United States consul general at Havana had notified the authorities at that place the previous evening of the intended arrival of the "Maine."

2. The state of discipline on board the "Maine" was excellent, and all orders and regulations in regard to the care and safety of the ship were strictly carried out. All ammunition was stowed in accordance with prescribed instructions, and proper care was taken whenever ammunition was handled. Nothing was stowed in any one of the magazines or shell rooms which was not permitted to be stowed there.

The magazines and shell rooms were always locked after having been opened; and after the destruction of the "Maine" the keys were found in their proper place in the captain's cabin, everything having been reported secure that evening at 8 o'clock. The temperatures of the magazines and shell rooms were taken daily and reported. The only magazine which had an undue amount of heat was the after ten-inch magazine, and that did not explode at the time the "Maine" was destroyed.

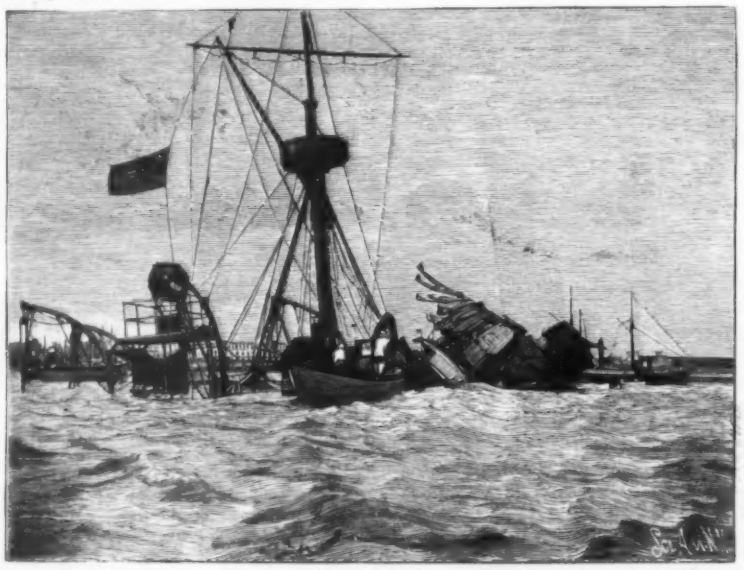


FIG. 6.—VIEW FROM STARBOARD QUARTER, LOOKING FORWARD—SHOWS DECK, CONNING TOWER AND BRIDGE THROWN TO STARBOARD.

FIG. 7.—VIEW OF MAINMAST AND TOP OF AFTER SMOKESTACK.

The torpedo war heads were all stowed in the after part of the ship under the ward room, and neither caused nor participated in the destruction of the "Maine." The dry guncotton primers and detonators were stowed in the cabin aft and remote from the scene of the explosion. Waste was constantly looked after on board the "Maine" to avoid danger. Special orders in regard to this had been given by the commanding officer. Varnishes, driers, alcohol and other combustibles of this nature were stowed on or above the main deck, and could not have had anything to do with the destruction of the "Maine." The medical stores were stowed aft under the ward room and remote from the scene of the explosion. No dangerous stores of any kind were stored below in any of the other storerooms.

The coal bunkers were inspected daily. Of these bunkers adjacent to the forward magazines and shell rooms four were empty, namely, B 3, B 4, B 5, B 6. A 15 had been in use that day and A 16 was full of New River coal. This coal had been carefully inspected before receipt on board. The bunker in which it was stowed was accessible on three sides at all times and the fourth side at this time, on account of bunkers B 4 and B 6 being empty. This bunker, A 16, had been inspected that day by the engineer officer on duty. The fire alarms in the bunkers were in working order, and there had never been a case of spontaneous combustion of coal on board the "Maine."

The two after boilers of the ship were in use at the time of the disaster, but for auxiliary purposes only, with a comparatively low pressure of steam, and being tended by a reliable watch. These boilers could not have caused the explosion of the ship. The four forward boilers have since been found by the divers and are in a fair condition. On the night of the destruction

of the "Maine," everything had been reported secure for the night at 8 o'clock by reliable persons through the proper authorities to the commanding officer. At the time the "Maine" was destroyed the ship was

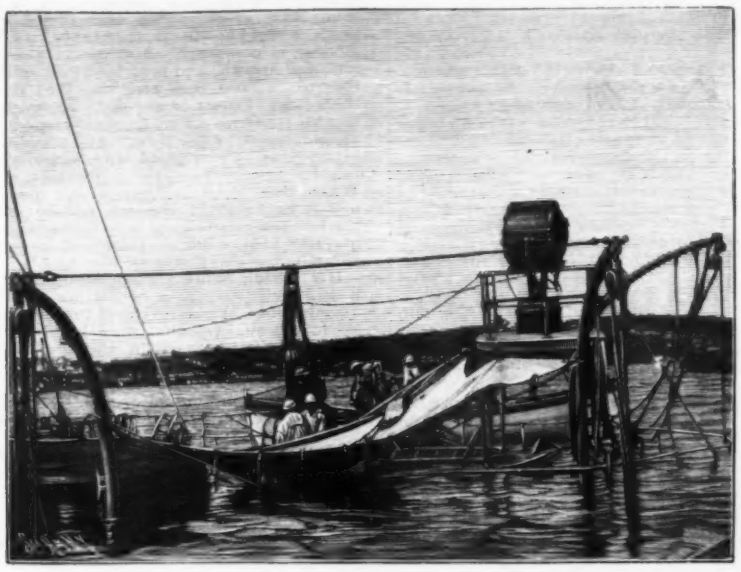


FIG. 8.—THE AFTER SEARCH LIGHT—DIVERS AT WORK ABOVE QUARTER-DECK.

quiet and therefore least liable to accident caused by movements of those on board.

3. The destruction of the "Maine" occurred at 9:40 P. M., February 15, 1898, in the harbor of Havana, Cuba, she being at the time moored to the same buoy to which she had been taken upon her arrival. There were two explosions, of a distinctly different character, with a very short but distinct interval between them, and the forward part of the ship was lifted to a marked degree at the time of the first explosion. The first explosion was more in the nature of a report like that of a gun, while the second explosion was more open, prolonged and of greater volume. The second explosion was, in the opinion of the court, caused by the partial explosion of two or more of the forward magazines of the "Maine."

4. The evidence bearing upon this, being principally obtained from divers, did not enable the court to form a definite conclusion as to the condition of the wreck, although it was established that the after part of the ship was practically intact, and sank in that condition a very few minutes after the destruction of the forward part. The following facts in regard to the forward part of the ship are established by the testimony:

A portion of the port side of the protective deck which extends from about frame 30 to about frame 41 was blown up aft and over to port. The main deck from about frame 30 to about frame 41 was blown up aft and slightly over to starboard, folding the forward part of the middle superstructure over and on top of the after part. This was, in the opinion of the court, caused by the partial explosion of two or more of the forward magazines of the "Maine."

5. At frame 17 the outer shell of the ship, from a point 11½ feet from the middle of the ship and 6 feet above the keel when in its normal position, has been forced up so as to be now about 4 feet above the surface of the water; therefore, about 34 feet above where it would be had the ship sunk uninjured. The outside bottom plating is bent into a reversed V shape (A), the after wing of which, about 15 feet broad and 32 feet in length (from frame 17 to frame 25), is doubled back upon itself against the continuation of the same plating extending forward.

At frame 18 the vertical keel is broken in two and the flat keel bent into an angle similar to the angle formed by the outside bottom plating. This break is now about 6 feet below the surface of the water and about 30 feet above its normal position.

In the opinion of the court, this effect could have been produced only by the explosion of a mine situated under the bottom of the ship at about frame 18 and somewhat on the port side of the ship.

6. The court finds that the loss of the "Maine" on the occasion named was not in any respect due to fault or negligence on the part of any of the officers or members of the crew of said vessel.

7. In the opinion of the court the "Maine" was destroyed by the explosion of a submarine mine, which caused the partial explosion of two or more of her forward magazines.

8. The court has been unable to obtain evidence fixing the responsibility for the destruction of the "Maine" upon any person or persons.

W. T. SAMPSON, Captain, U. S. N., President.
A. MARIX, Lieutenant-Commander, U. S. N., Judge Advocate.

UNITED STATES FLAGSHIP NEW YORK,
March 22, 1898, off Key West, Fla.

The proceedings and findings of the Court of Inquiry in the above case are approved.

M. SICARD, Rear Admiral,
Commander-in-Chief of the United States Naval Forces on the North Atlantic Station.

It should be mentioned that Captain Sigsbee stated during his examination that he had been informed by the captain of the "City of Washington" that "he had never known, in all his experience, which covers visits to Havana for five or six years, a man-of-war to be anchored at that buoy," at the buoy at which the "Maine" was anchored, "and that he had rarely known merchant vessels to be anchored there, and *that it was the least used buoy in the harbor.*"

Commander G. A. Converse, United States navy, was summoned by the court as an expert witness on the action of explosives. He testified that he had been thirty-six and a half years in the naval service, and had made a careful study of the nature and effects of explosives. His experience included eleven years spent at the naval torpedo station. The importance of the testimony of Capt. Converse is such as to warrant its being given in full.

Q. Captain, will you please examine the sketches which have been shown you and tell the court whether, in your opinion, the explosion of one or all of these forward magazines, or their partial explosion, would leave the bottom of the ship in the condition which now exists, as represented in these sketches?

(Exhibit H was shown witness.)

A. The sketch might represent two explosions of entirely different natures. That part of the sketch represented here as frame 14½ to frame 18½, aft, in the direction of frame 23, might be produced by the explosion of a comparatively large mine of not violent explosive matter at some distance below the bottom of the ship; whereas the part abaft of frame 23 has all

FIG. 9.—STERN VIEW—RAIL OF SUBMERGED QUARTER-DECK IN FOREGROUND.

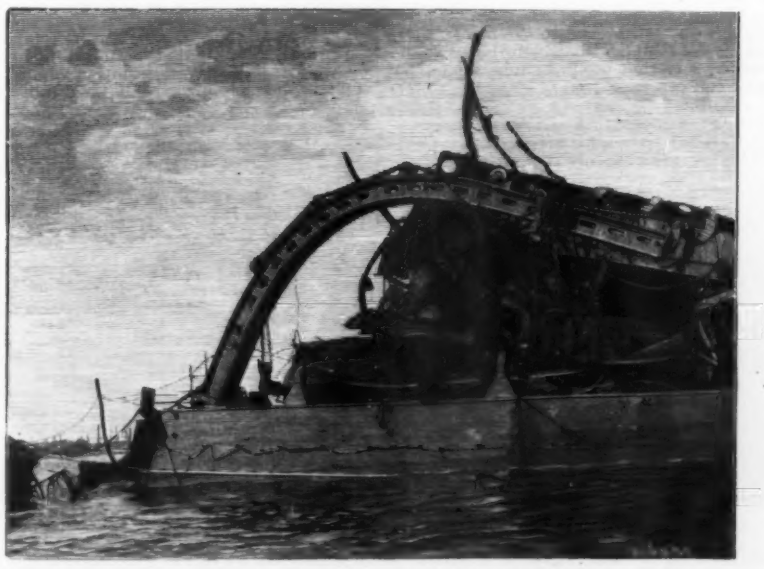


FIG. 10.—THE FORWARD HALF OF SUPERSTRUCTURE—DECK BLOWN OVER AND BACK UPON REAR HALF.

the appearance of the effect produced on iron plates by a high explosive in close proximity to it. There are in all explosions two general effects: First, the upheaval of the water caused by the direct action of the explosion, followed almost immediately afterward by the second upheaval of water and mud, being the reaction of the water from the sides and the bottom, which rushes in to fill the crater produced by the first explosion. But the location of this upheaval and the distortion of the keel in the present instance does not appear to have been formed by the secondary effect referred to above. It is too far forward; too remote. It is too far from the place marked "Débris," which must be somewhere about frame 27. If that is 27, then the distance, as marked, from frame 18, will be eleven frame spaces, or 44 feet forward of what would appear to be the crater of the most violent explosion.

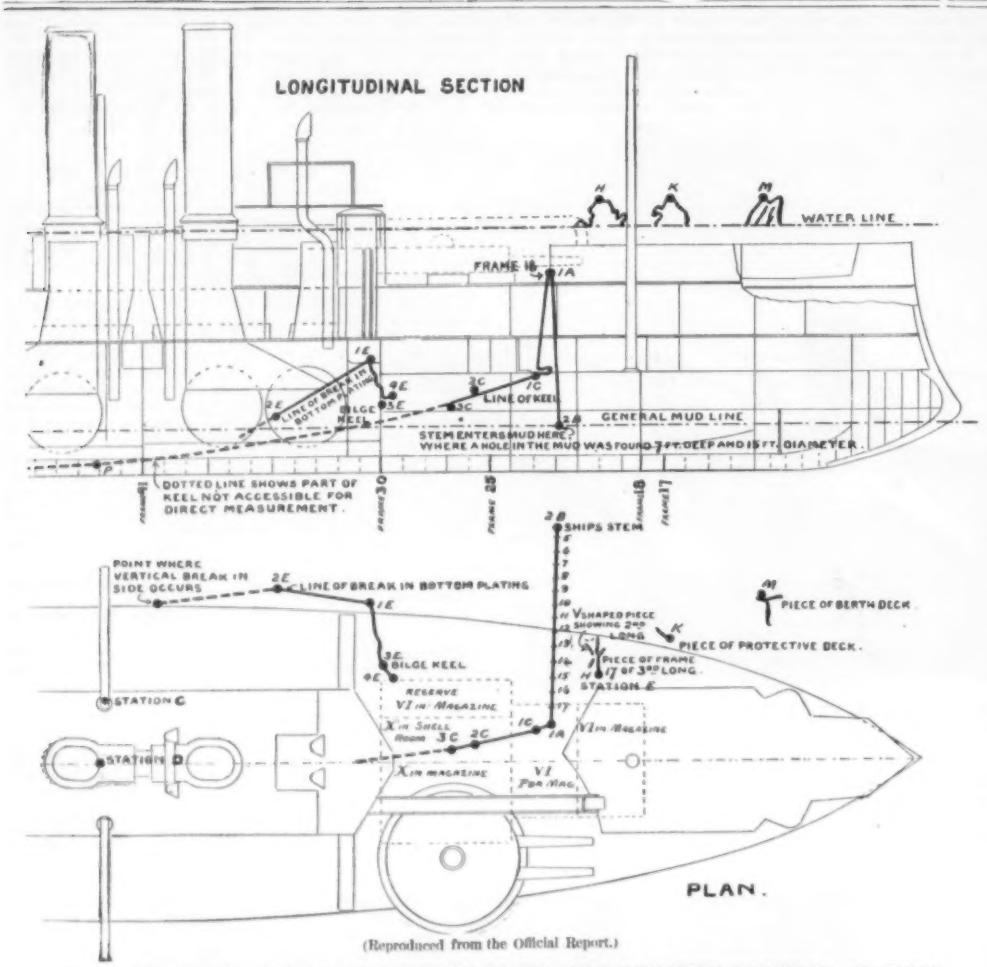
Q. Then to what kind of an explosion do you attribute the force that caused this bending of plates and keel on sketch?

A. I am of the opinion that it could be produced by the explosion of a submarine mine containing a large amount of the lower explosives—gunpowder or similar—not in contact with the ship, but some distance below it, perhaps on the bottom.

Q. Looking at the sketch shown you, especially at that portion of the keel which has frame 18 on top, and the plates—bent plates—forward of it, excluding entirely all portion abaft of it, could this part which you are now told to consider have become so distorted from the effects of an internal explosion alone?

A. I do not think it could. I have never seen anything in my experience which would lead me to believe that it is possible to produce the effect indicated by any explosion within the interior of the ship in that immediate vicinity.

Q. Looking at the sketch shown you, and informing you that the forward 6-inch magazine and the fixed ammunition room were at that part of the keel which is represented as nearly vertical—that is, frame 18 to frame 24—could the conditions as shown forward of


LONGITUDINAL SECTION
WATER LINE
FRAME 18
1A
LINE OF KEEL
GENERAL MUD LINE
STEM ENTERS MUD HERE, WHERE A HOLE IN THE MUD WAS FOUND 7 FT. DEEP AND 15 FT. DIAMETER.
DOTTED LINE SHOWS PART OF KEEL NOT ACCESSIBLE FOR DIRECT MEASUREMENT.
SHIPS STEM
POINT WHERE VERTICAL BREAK IN SIDE OCCURS
LINE OF BREAK IN BOTTOM PLATING
PIECE OF BERTH DECK.
PIECE OF PROTECTIVE DECK.
BILGE KEEL
STATION C
STATION D
STATION E
PLAN.

(Reproduced from the Official Report.)

FIG. 11.—DIAGRAM SHOWING BY HEAVY LINES THE PRESENT POSITION OF KEEL AND BOW OF "MAINE."

frame 24 have been caused by an explosion of those two magazines or of any magazine abaft of frame 24?

A. I do not think it could.

Q. Do you think, then, necessarily, there must have been an underwater mine to produce these explosions?

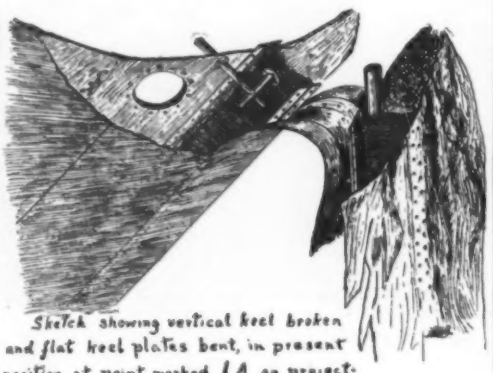
A. Indications are that an underwater explosion produced the conditions there.

THE PSYCHOLOGY OF INVENTION.*

By Prof. JOSIAH ROYCE, Harvard University.

IN compliance with the kind request of our president, I have consented to open this discussion; but I do so feeling that the subject is not one which I myself should have chosen to discuss. Its importance I recognize, as we all do; but its difficulty is notorious. In the present state of our knowledge of the processes involved I do not think that it is possible to attempt much more than a statement of problems, and some indication of those methods of work by which in future we may obtain more light. With this understanding—that I am here not to state results, but to assist, however little, in opening, or at least in suggesting, some lines of inquiry—I accept the proposed task, while I am fully aware of the very modest character of the little contribution that I can make. This contribution will consist: (1) of a definition of the problem, (2) of a thesis as to certain pretty vague general conditions which favor inventiveness, and (3) of some merely illustrative experimental reports, intended not to prove but to make more comprehensible my thesis.

It is difficult of course to give any psychological definition of what is meant by invention. Ordinarily, if we take the word "invention" in a decidedly wide sense, we mean by invention an important new idea or system of ideas, or an important device or system of devices, by means of which such new ideas are expressed. The first way in which this general definition has to be called vague is due to the fact that the word "important" is not a term of description but of estimate. When is a new idea or a new device important enough to be called an invention? There is no scientific answer to this question. And the value of a given mental product is something with which the psychologist, who considers how that product came to pass, has only an indirect concern.


Sketch showing vertical keel broken and flat keel plates bent, in present position at point marked 1 A on projection of injuries. Redrawn from drawing made by Chief Gunners Mate A. Olsson, U.S.N. (diver).

(Reproduced from the Official Report.)

FIG. 12.—SKETCH SHOWING BROKEN KEEL AT POINT MARKED 1 A IN FIG. 11.

The second respect in which this definition just suggested is necessarily vague has to do with the meaning of the word "new." In a strict sense, one may say that, while we may have new experiences to any extent you please, we cannot have absolutely new ideas, since an entirely new idea is a contradiction in terms. In the same way, every device, such as a word, a sentence, a poem, a mechanism, is inevitably based upon former devices, is composed of elements previously existing and well known, and is so far never entirely new. On the other hand, it is also true that in all mental life there is an element of novelty, Every moment of our mental existence differs in some respects from any previous moment of our lives. And about our actions and expressions of our ideas there are similar elements of relative novelty, however slight this novelty may be. When, then, shall an idea or an invention be called new? Still a third element of vagueness enters into the foregoing definition, in so far as, whenever we speak of a new idea or device, the question necessarily arises: For whom is this device or idea new?

If I myself think a given thought for the first time, if I myself produce a contrivance that I never produced before, the act involves for me what is relatively an invention. On the other hand, with reference to the race at large, or to the thoughts and habits of the community in which I live, the idea or the contrivance may be very old. Inventions are, therefore, inventions either for the individual or for the society of which he is a member. Ideas and devices are new in the life of this person only, or in the life of mankind in general; and one has to bear this distinction in mind in estimating novelty. So far, then, the importance and the novelty of any invention are matters only vaguely definable; and one has also to define for whom the invention is in any case to be a novelty.

If, in view of the difficulty of defining invention in all these respects, we try to consider afresh the situation in which our questions arise, a glance at well known psychological considerations will enable us to characterize our problem more exactly. We cannot exactly define what is worthy to be called a valuable invention, but we can define some of the processes that condition inventiveness. The acts of any intelligent human being who has received training are, on the one side, expressions of the law of habit. That is to say, they are repetitions, more or less exact, of acts and systems of acts that have been performed before. Habits themselves are the results of adjustment to environment. The sense impressions to which an organism has been subjected, working upon the basis of its inherited tendencies, have led to the gradual moulding of the original instincts, impulses and reflexes of the organism in question; and the outcome of all this moulding is a system of habits which tends toward an invariable routine, although the routine actually attained by any individual organism is never during its normal life absolutely invariable. Some of these habits, namely, the most complex and the most deliberate, are accompanied by consciousness; such habits we call intelligent. On the highest levels, the acts in which these habits get embodied are the expression of ideas or of trains of ideas, of thoughts, of states of mind which involve a knowledge of the environment.

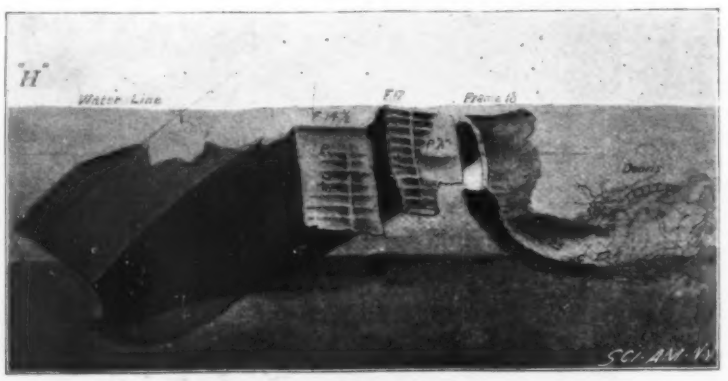
Now, in consequence of the general laws of habit, the most of what is done during the mature life of any intelligent being pretty closely resembles what has been done before. The habits expressed when we use language are, for instance, old habits. The words that we use have been used before. But under certain circumstances a change of stimulation may cause already acquired habits to vary in ways which involve new combinations of old but already intelligent activities—and in ways which do not merely repeat current facts of experience. These independent variations of intelligent habits constitute the general region within which are found the activities that we call invention; and the ideas or system of ideas that accompany these variations of intelligent habit are, on the mental side, more or less inventive psychoses. Thus a new combination of words may constitute a poem. This combination is not wholly due to the present facts of the poet's outer experience. It is in so far an independent variation of his habits of speech. Thus all inventions are relatively independent variations of intelligent habits, and the psychological question as to the origin of inventions is parallel to the biological question as to the origin of variations. Meanwhile it remains true, as before, that not every such variation of intelligent habits, but only the important variations, are usually dignified by the title of invention. But the psychologist is more interested in the appearance of the variation than in its importance for the individual.

Thus one may view inventions in their relations to an individual life. If we turn from inventions, in so far as they are novelties in the individual's life, to the variations of habits that are novel in the life of society, we are met by a further situation which may be briefly summarized as follows: What the individuals in soci-

* Read before the annual meeting of the American Psychological Association, held at Ithaca, December 28, 1897.—With acknowledgments to The Psychological Review.

(Reproduced from the Official Report.)

FIG. 13.—VIEW ABOVE FORE PART OF WRECK SHOWING PART OF FRAME 17. PIECE OF PROTECTIVE DECK AND PIECE OF BERTH DECK.



(Reproduced from the Official Report.)

FIG. 14.—FACSIMILE OF OFFICIAL SKETCH (EXHIBIT H) SHOWING CONDITION OF WRECK UNDER WATER AS FAR AFT AS FRAME 28.

ety mostly learn to do is to imitate other individuals. The intelligent adjustment of the social being to his environment involves conforming his ways to the ways of other people. As Prof. Baldwin has pointed out, the law of imitation in the social order is a sort of extension of the law of habit in the individual life. In his habits the individual repeats himself. In his imitations, even when, as he learns them, they are for him novel, the individual repeats what society has already accomplished. For this reason most variations of individual habit in the social being, most inventions of an individual life, involve no variation of the habits of society, involve no essentially novel ideas or deeds. On the other hand, it is true that, despite this tendency to uniformity, there do appear in social life from time to time relatively original independent activities—deeds that have never been done before by anybody, combinations of ideas that in some respects are not due to imitation, that are not the results of the past habits of individuals simply repeated, or of the habits of society simply imitated. If these variations of our imitative activities themselves get imitations from others, they constitute in the social sense inventions. Viewed from the social point of view, they then come to have the same relations to what men in general do as in the individual life the relatively novel variations of habit have to the past deeds of the individual.

To sum up so far, we have thus two distinct processes worthy to be called inventive. Inventions involve intelligent variations of habits already acquired and present in the individual; and where inventions are socially important, they involve similarly independent variations of imitative activities, or variations of social habits. The question about the psychology of invention is therefore twofold. It is, first, Under what conditions does an individual tend to vary his own already established and intelligent habits? and, second, Under what conditions does the individual tend to be what is called original, namely, not imitative? The two questions are, of course, very closely connected.

The question of the variability of our individual habits, where the variations are of an intelligent grade, and accompany the appearance of relatively novel ideas or combinations of ideas, constitutes a very wide and difficult problem. What we know about it may be indicated by considerations which every psychologist will recognize. In the most limited degree it is true of every act that, because it is done under novel conditions of experience, it tends to involve some variation of former acts. It is because of this plasticity to experience that we originally acquire our habits at all. This primary sort of plasticity remains, to a certain extent, present even long after our habits have reached an intelligent grade. One lives and learns. But mere learning by experience, adjusting our ideas to presented facts, is rightly distinguished from true inventiveness, which involves novel ideas and acts that are not merely determined by outer experience. In the next place, the organs used in our more active life tend in an extremely complex way to acquire one the habits of another, so that unconsciously we all of us are in possession of a great number of habits of movement which have never been purposely acquired, and have never been merely adjusted to outer facts, but which have been imitated, so to speak, by one group of nerve centers in consequence of organic connections with another group. Thus, one can on occasion write with the foot or with the knee. The left hand is frequently able to repeat symmetrically the movements already learned by the right hand. Such unconscious coeducation of our various organs is itself a source of considerable independent variability in our actions. For a habit to which one group of organs has been adjusted becomes ipso facto altered when it is imitated in this unconscious way by another group of organs. And everybody has a great deal of skill of this unconscious sort which can be called out on occasion, and which can be adjusted to new tasks. Finally, those laws which psychologically appear as the laws of association of ideas involve, as every one knows, a good deal of relatively independent novelty both of ideas and of activities, whenever our organisms are brought into new situations.

Thus mental processes which Stout has called "Relative Suggestion" involve a certain independent novelty in the suggested ideas. For instance, my habits may have already determined, on the mental side, the combination of two ideas, A and B, where A and B are contents standing in a given relation to one another. This habit is aroused, for any reason you please, in the presence of some new content, P; and the associative process may so work that I thereupon form a relatively new idea, Q, which stands in the same relation to P as that in which B has stood to A. Thus, in consequence of this sort of relative suggestion, Q appears in my mind as a novel mental content, not directly derived from experience. The mere form of the combination, A B, has been repeated, without the repetition of the matter. On the motor side this sort of permanence of form with alteration of content in the expressions of our habits is not unfamiliar, and appears in all our more intelligent actions. In this way we tend not merely to repeat literally our former acts, but to produce acts that have merely the same form or general type as former acts.

Most of our intelligent habits are thus what one may call generalized habits. Such, for example, are the habits of the syntax of our mother tongue. These involve not merely the power to repeat old phrases, but the power to make new combinations of an old type. Such habits are essentially, within limits, variable habits. In a measure, they are habits which involve a certain novelty of behavior at every new expression of the habit. There is routine running through all this novelty. But it is the routine of form, not of content, or at least not altogether of content. Our social habits show endless variations of this tendency to permanence of form in conduct amid great variety of detail. Consider, for instance, the habit of repartee, the habit of courteously adapting one's behavior to the present social atmosphere, and many similar cases. Athletic habits involve much of the same sort of generalization. The skillful player may at any moment do something which is in content more or less different from anything that he ever did before; but his skill shows itself in the form. Now, in all these cases, where the nature of a habit is such that a given form is preserved through great variations of content, whether in ideas or in actions, the variability that appears is not itself an exception to the law of habit. On the contrary, in such cases the intelligent habits in question are, as I just said, essentially habits of variation, although the variation is in most such cases subordinate to the routine, and the range of variation is very sharply limited. Habits of this sort constitute precisely what we mean by skill. All skill involves, therefore, some more or less obvious, although limited, degree of inventiveness.

In one further direction, however, we can understand the way in which our habits may slowly vary, and vary in useful directions. Prof. Baldwin has laid great stress upon the influence of the "try, try, try again" tendency in the early stages of formation of habit. At any stage of our development we are possessed of an imperfect adjustment. We elaborately repeat that adjustment in constantly altering situations, with a steady disposition to eliminate any useless elements. Here the constantly changing situation involves a constant slight alteration of what we do. A steady selection of the slight variations leads to improvement of habit.

To sum up this brief survey of the factors in the individual variation of habit, we see that in all their routine our habits have in normal cases a considerable tendency to independent variation, apart from our direct dependence on the facts of outer experience, although this variation does not in general tend to produce very great or very important alterations of behavior, except during the formative periods in the life of an organism. The defect of all such considerations, if regarded as an explanation of the variations which we call, in the narrower sense, significant or true inventions, lies in the fact that all these tendencies are in general useful in so far as they lead toward routine, and tend to make both our life and our knowledge systematized, and in the end simplified. The great inventions of humanity all seem to include processes more complex, and more mysteriously rational than this ordinary routine of variability will explain. Skill is not talent. The artisan is not the artist. The apt scholar is not yet the discoverer.

If we pass to the relations between the individual and society, we must admit that just as all our habits within limits normally tend to vary, so all the imitative social processes normally involve certain individual variations. Every imitator is, in his own little way, an originator. For every organism inevitably colors its imitations with its own individual qualities. Our handwritings are different, even where we have been taught to imitate the same models. Our voices are individually recognizable in their variations, even when we sing the same note or repeat the same words. The imitative life is in so far also an individual life. And every individual is thus a possible source of socially important variations.

Chance may make anybody a socially prominent person, just as Capt. Boycott's name but a few years since entered, perhaps forever, the English Dictionary. Moreover, since no two individuals can have precisely the same social environment, since the range of acquaintances, not to speak of closer affections, is inevitably an individual range, no two individuals have the same models to imitate. Where two individuals are trying to imitate the models or fashions of conduct presented in the life of the same social group, every individual has more acts suggested to him than he can possibly succeed in carrying out, and, therefore, each of our two individuals is obliged to select for himself what models he proposes to imitate. The social order is a sort of elective system of social instruction, where every individual to a certain extent chooses his own models. Hence, despite the vast power of social routine, despite the universal prevalence of imitation, there is always, even in the life of a savage tribe, a great deal in the social order that constantly tends to favor social variation. Yet this variation is confined within comparatively narrow limits, except in the case of the most progressive societies, and of the most plastic individuals.

If we now put together, after our brief survey of the known field, the social and the individual factors that tend to favor variation of habit and of idea, we thus find that while there are important factors tending to work against the too literal repetition of habits and of ideas, it is hard to point out precisely the conditions that favor those rapid and significant changes in the routine of action and of intelligence which appear when inventions of greater importance take place. And so, since there is often a wider range of variation favored and explained by decidedly pathological conditions, it becomes natural enough that some psychologists should have looked to pathological explanation as sufficient for all the forms of large variation, whether useful or useless. Hence the general basis in fact for the now so frequently current view that all great inventions and inventors are more or less pathological phenomena. Yet I do not believe that we are limited to such pathological explanations. In any case, by this survey of the known conditions, we reach the statement of our problem itself, which is this: What factors tend to produce such variations of habit, either in the individual life or in the activities of society, as more specially include the significant variations, the valuable novelties, that we call invention? Are such more extreme variations simply special instances of the ordinary processes that, as we have seen, tend to a constant, minute and relatively insignificant variation of our routine? Are such processes, on the other hand, due to wholly chance interferences with the normal laws of habit, to interferences of no definable type whatever? And is the problem of invention simply the problem as to how the useful variations get selected when in this wholly atypical way they happen to occur? Or can we define beforehand the conditions under which valuable variation is likely to take place?

As I said at the outset, it is rather the statement of our problem than its solution that I can hope here to attempt. Yet at this point one consideration occurs to me as worthy of notice. It is a consideration suggested by the history of invention. Important inventions do not, in general, occur except under particular social conditions. And the social conditions have their definable type. What is this type? In the individual the most important independent variations of his habits occur during the growth of his social sense. The mere organic growth of the brain has, of course, a good deal to do with this youthful variability. But there can also be no doubt that it is the social sensitiveness of the young which is one very important factor in the same process. On the other hand, if we pass to mature minds, there cannot be the least doubt that individuals themselves vary more in their own habits, become more productive of novel processes, and contribute more to the variation of social habits, when the conditions are such as to favor the social tendencies often called by the general name individualism. And individualism means a mass of social tendencies having a definable type. In other words, the individual varies more in the long run when the society in which he belongs expects him to vary more, when variation is encouraged, when independence, private enterprise, is favored by the social environment. This is a very simple consideration, and very easily verified in history, as well as in individual psychology. It is a consideration which the psychologist cannot leave out of account. Children in the country, or children brought up in comparative isolation from school routine, often show a much greater inventiveness in their games and romances than do children early submitted to the routine of large schools. Anybody who has watched this process in a relatively isolated child recognizes at once that the child is still dependent upon his social environment for his ideas, and that also the relative independence of his situation favors the variation of his habits. In society the same thing holds. The periods of great individualism have been periods of relatively great inventiveness. This was the case in Athens at the great period. It was the case in the Renaissance. It was the case during the revolutionary period at the close of the last century and the beginning of this. It is the case wherever, in a highly intelligent people, similar conditions have prevailed. Nor can the processes present at such periods be referred simply to the happy chance that geniuses were then produced. To be sure, I have no idea of explaining the greatest cases of genius, or of reducing them to any one law. I am here referring to the average inventiveness of the really clever men who, in the civilized races, are constantly produced. In the great age of individualism, the lesser men invent as well as the greatest. On the other hand, the uninventive ages in the history of civilized people are characterized, not by the mere absence of geniuses, but by the helplessness of the men of talent to accomplish anything of importance. Now, what is known of the biological conditions of heredity would make it very improbable that, extraordinary genius apart, the organic basis for the variation of talent, for the appearance of milder forms of originality, should be very different in one age, in a given stock of people, from what it is in another age in the life of the same people. But, in the life of any civilized stock there are periods of invention and periods of stagnation, and it seems to me that we may say, of society, that if we here deliberately leave out the cases of the greatest geniuses, civilized society, while dependent upon biological processes for the production of its men of talent, still gets out of these men of talent, in any age, very much what it deserves to get—i. e., what in a proper way it asks for. It cannot produce the great genius, and it cannot make stupid men clever, but from its lesser men, who are still men of real ability, it gets within limits very much the degree and the type of inventiveness that the social situation suggests. In a poetical age, poetry is invented by the second rate poets; and some of it is very good poetry. In a scientific age, scientific discovery is the order of the day, and the men of talent are scientific inventors. During a period of war, military ability is encouraged. Of course, no such social encouragement can produce Shakespeare's plays, or Darwin's discoveries, or Napoleon's achievements. And only heredity can account for the very wide differences between clever men and stupid men, or explain why men of talent exist at all. But the minor and still important inventiveness of the men of talent, the men of the second grade, is somehow due to a social stimulation which sets their habits varying in different directions. And this stimulation is of the type which abounds in periods of individualism. So much for a very obvious and general suggestion, which, of course, once more helps us to state rather than to solve our problem.

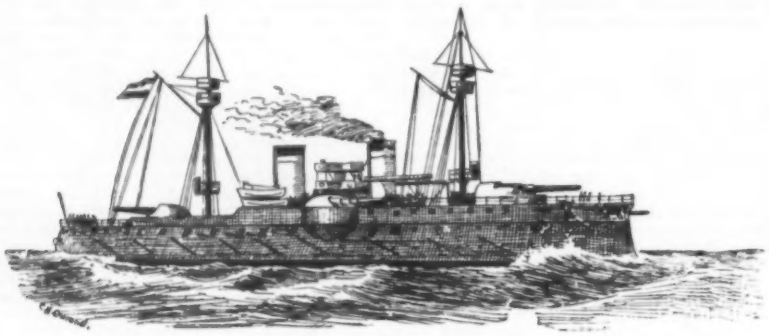
I expect, of course, the immediate question, How can one's social situation tend to make one more inventive, more variable in one's significant habits, than one otherwise would be? For, once more, the primary character of the social influences to which we are exposed is that, within limits, they set us to imitating models, they tend to make us creatures of social routine, slaves of the mob, or obedient servants of the world about us. On the other hand, if all that society says to a man at a given time is, Be inventive, be original, it seems indeed a very serious problem how the suggestion can possibly work; for if a man is left to his own devices, and tries to invent something of importance that is novel, he so often finds himself merely repeating old habits, or merely imitating models, that he often concludes that his inventiveness cannot be stimulated by any conscious suggestions whatever.

(To be continued.)

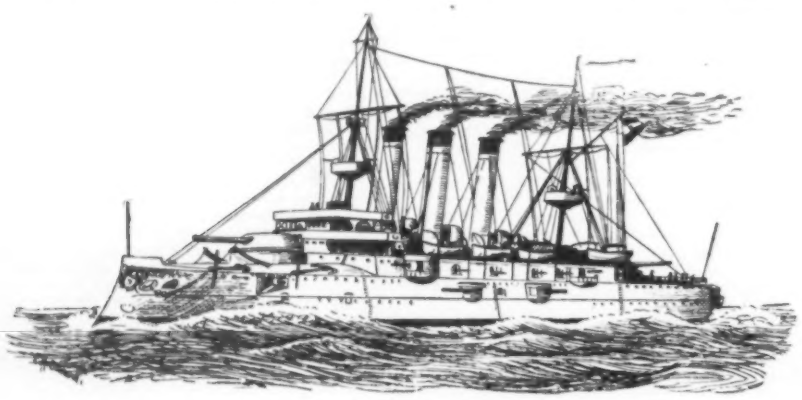
During the recent dedication of the new physical chemical institute of Leipsic University, Prof. Ostwald conducted a number of highly interesting experiments to show the action of liquid air, through the intense cold caused by its evaporation, upon the physical and chemical properties of various substances. It has been found possible to construct glass containers in which large quantities of liquid air can be stored. This fluid has a gray-blue color and is turbid from the presence of solid carbonic acid suspended in it, which can be readily removed by filtration. A rubber tube introduced into liquid air becomes as hard and brittle as glass. Cinnabar loses its characteristic red color and changes to a reddish yellow. Liquids become viscous, crystallize or solidify. Hydrochloric acid forms a thick sirup; ether becomes as hard as stearin. Chlorine gas changes to a yellow fluid; ammonia gas the same. Illuminating gas loses its lighting power, and hydrocarbons, as benzol and ethylene, separate out. Oxygen gas, introduced into liquid air under ordinary atmospheric pressure, becomes liquid; hydrochloric acid freezes, accompanied by such violent contraction that the receptacle threatens to break.—Ph. Ztg. Pharmaceutical Era.

THE NAVY OF SPAIN.

THE Military Information Division of the Adjutant-General's Office of the United States Army has just published a "List of the Battleships, Cruisers and Torpedo Boats of the Spanish Navy," with illustrations of seventeen of these vessels, with particulars as to classification, dimensions, speed, armament, etc., compiled from such reliable sources as the publications of the Office of Naval Intelligence, Brassey's Annual, Clowes' Naval Pocket Book, etc. We give from this publication illustrations of these vessels, which are of special interest at the present time, in view of the possible war between the United States and Spain.



"PELAYO."



"EMPERADOR CARLOS V."

The question which first arises in the mind is whether we could defeat Spain upon the high seas. The average citizen would probably say that there was no doubt we could do so, but to the professional mind the view seems to obtain that we could in time annihilate the fleets of Spain, but the task appears to be not so easy of accomplishment as the layman thinks. It is, of course, better to overestimate rather than underestimate the fighting power of an opponent, or best of all to rate him at his true value; hence we may still admit, as stated in the SCIENTIFIC AMERICAN for April 2, that Spain would go into war as far as her ships are concerned with a homogeneous, compact and very formidable fleet—one which, properly handled and bravely fought, would be a by no means unworthy opponent for the powerful ships of the United Stafes navy. Each fleet would be strong where the other is weak, and, taking the fleets as they stand, swift, heavily armored cruisers and deadly destroyers against mighty battleships and more lightly armored cruisers, independently of the "men behind the guns," the result of a conflict would be by no means so certain as is supposed. The men behind the guns, however, would be the controlling factor, and the American public has supreme confidence in the pluck of the crews and the skill and daring of our naval officers, which renders it so confident of final victory.

The Spanish line can boast of only one first-class battleship, the "Pelayo," a steel barbette battleship of 9,900 tons displacement. She is 330 feet in length; her beam is 66 feet and her maximum draft is 24 feet 11 inches; her speed is 16 knots an hour; her normal coal supply is 800 tons and her complement of officers and sailors is 600 men. Her armor consists of a belt 17¾ inches thick; her large guns are protected by 19¼-inch armor, and her deck armor is 4 inches. She carries two 12½-inch, two 11-inch and nine 5·5-inch rapid-fire guns and twelve 4·7-inch guns and has seven torpedo tubes. She has two military masts, ram bow, and has the bridge between the smokestacks, and two sponsons amidships, one on each side. She is a good ship, but possesses the fatal defect of having no armor protection between the barbettes and the belt. On this account high explosive shells bursting between the barbettes might easily put them out of action.

With the exception of this one first-class battleship, the Spanish line of battle would consist of a magnificent fleet of eight swift, heavily armed and heavily armored cruisers, similar in size, speed and power, and admirably adapted to act together in a concerted fleet action. These ships are all built to carry a large normal coal supply of 1,200 tons, which would seem to indicate they were built for just such emergencies as now confront them.

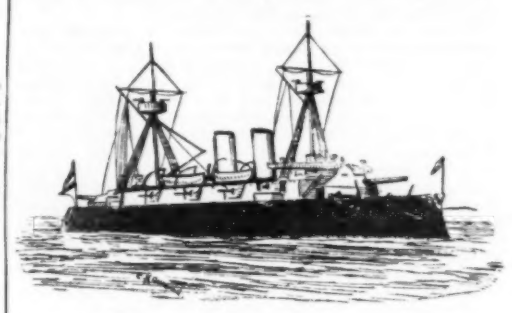
The largest and most important of these ships is the "Emperador Carlos V." She is a steel ship of 9,235 tons displacement; she is 380 feet long, her beam is 67 feet, and her maximum draft is 25 feet; she can make 21·9 knots speed and carries 1,200 tons of coal and her complement consists of 535 men. Her curved deck plating is 6½ inches thick and her secondary battery is protected by a continuous plate of 2 inches of Harveyized steel. She carries two 11-inch guns disposed in two barbettes of 10-inch steel and a secondary battery of eight 5·5-inch and four 3·9-inch rapid-fire guns; she has two military masts with signal yards, three tall slender smokestacks and a ram bow and she is equipped with six torpedo tubes.

The "Cristóbal Colón," which was built in Italy, is a sister ship of the "Varese," belonging to Italy. The "Cristóbal Colón" is a steel ship of 6,840 tons displacement; she is 328 feet long; her beam is 59 feet 8 inches and her maximum draft is 24 feet. She can make 20 knots an hour, and carries 1,000 tons of coal and a complement of 450 men. She carries two 10-inch armor-piercing guns in 6-inch barbettes, one forward and one aft; she has one military mast between the smokestacks and has four torpedo tubes. The remarkable feature of this ship is the extensive armor protection, which is so complete as to entitle her to be called a battleship rather than a cruiser. A 6-inch steel belt encircles the whole water line; above this is a redoubt of continuous 6-inch steel which completely protects a battery of ten 6-inch rapid-fire guns, and above this is another battery of six 4·7-inch guns; her deck armor is an inch and a half thick.

Following these two ships in importance is a group of six sister ships, two of which are already very familiar to the people of New York. They are the "Almirante Oquendo," the "Cardenal Cisneros," the "Cataluña," the "Princesa de Asturias," the "Infanta Maria Teresa" and the "Vizcaya." The "Maria Teresa" represented Spain at the Grant Memorial services last year and lay for some time off Riverside Drive in the Hudson River, and the "Vizcaya" visited this port immediately after the "Maine" disaster.

Each of these ships is built of steel and has a displacement of 7,000 tons, and a speed of 20 knots, and a complement of 500 men. They are 340 to 347 feet long, and the beam varies from 61 to 65 feet; the maximum draft is 21 feet 6 inches to 21 feet 10 inches. They are provided with a belt of 12-inch steel, at the top of which is a protective deck which is two to three inches thick at each end. In this belt is an armored tube which rises to connect with a barbette of 10½ inches of steel, and in the barbettes are 11-inch armor-piercing guns. Between these guns is a battery of ten 5·5-inch rapid-fire guns, and there is also a battery of lighter guns. Six to eight torpedo tubes are provided.

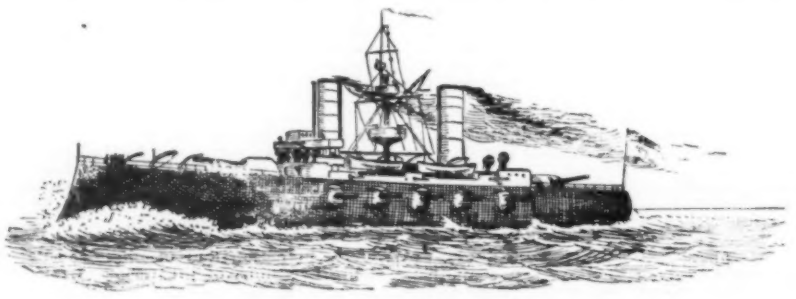
The "Numancia" is an iron broadside ship of 7,305 tons displacement; she is 314 feet 10 inches long; her beam is 55 feet 10 inches; her maximum draft is 25 feet 3 inches; she can only make 8 knots an hour, and her normal coal supply is 1,100 tons: her complement is 600 men; her armor belt is 5½ inches thick, and the guns are protected by 5 inches of steel. Her armament consists of eight 10-inch muzzle-loading Armstrong rifles, seven 8-inch, one 7·8-inch and eight machine guns, and three light guns and two torpedo tubes. She is to receive new machinery and six 6·2-inch rapid-fire and six 4·7-inch rapid-fire guns. She is an antiquated model, and will be greatly transformed when the new repairs have been made. Our engravings show the ship before she was remodeled and the ship as she will appear when the repairs are finished.



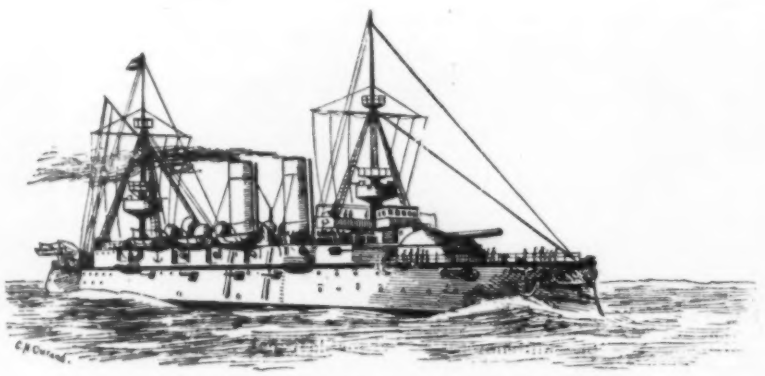
"INFANTA MARIA TERESA." "VIZCAYA." "ALMIRANTE OQUENDO."

The "Lepanto" is a steel cruiser of 4,826 tons burden; she is 318½ feet long; her beam is 50 feet 6 inches, and her maximum draft is 20 feet; she can make 20 knots an hour; her normal coal supply is 1,100 tons, and she carries a complement of 276 men. She has no armor belt, but has a protective deck 4·75 inches thick. She carries two masts, with signal yards and fighting tops. She is a protected cruiser with medium armament; she carries four 7·8-inch guns, six 4·7-inch rapid-fire guns and six 6-pounders, etc., and five torpedo tubes.

The "Hernan Cortez" is a type of gunboat which has been useful in Cuban waters to restrain filibustering. She is a steel vessel of 300 tons displacement. Her length is 154·9 feet; her beam is 21·5 feet and her maximum draft is 6·3 feet. She is manned by 53 men and can make 12 to 13·5 knots per hour. Her normal coal supply is 67 tons. She carries one 5·12-inch Parrott gun.



"CRISTOBAL COLON."

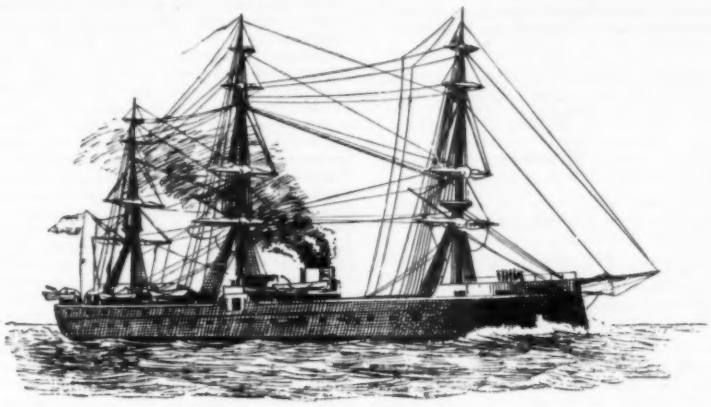


"CARDENAL CISNEROS."

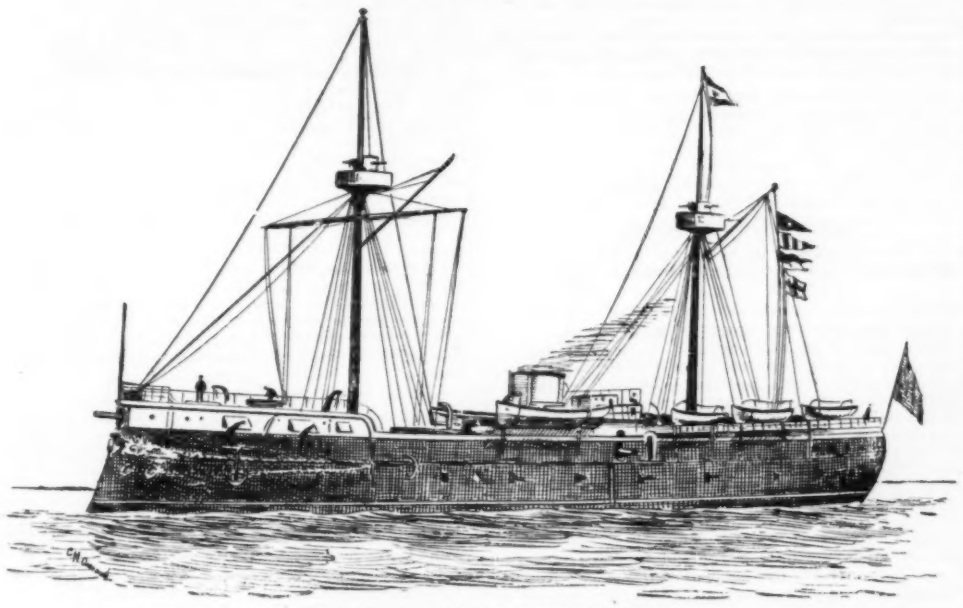
ELECTRIC LIGHTING IN RUBBER WORKS.

THIS question is of great importance to rubber works in which benzene and other highly volatile liquids are in constant use. It is interesting to read some views

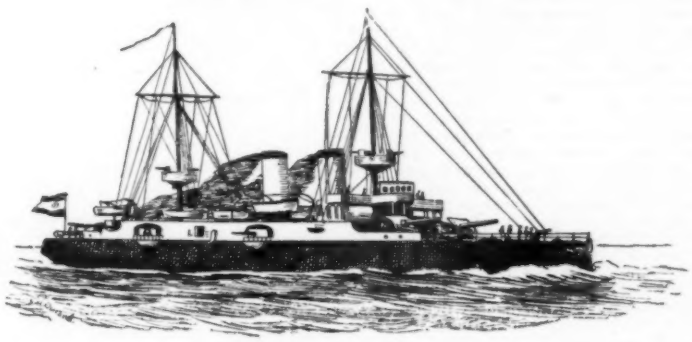
expressed in the Gummi Zeitung. One correspondent is convinced that a damaged electric incandescent lamp would never cause an explosion, as the filament would at once cease to glow. This is, of course, a fallacy, which one can still read in treatises on electric lighting. The same correspondent, who, in spite of that belief, would not neglect any precaution, reports ously, and whether they are perhaps caged in like safety lamps. But the carbons must be renewed in any case, when an explosion would be more than usually likely. Nothing has ever occurred, of course, or the arc lamps would long since have been banished. Another correspondent points out that all wires should be placed in gas pipes, that all switches and fuses should be placed outside the dangerous rooms and be especially protected, and the lamp bulbs provided with outer glasses and wire cages. Under these conditions he welcomes the electric light, which has been admitted into the petroleum works at Leyh and Cosel, on whose behalf he writes. The safest plan is, of course, to arrange lamps and everything belonging to them outside, behind windows or skylights.



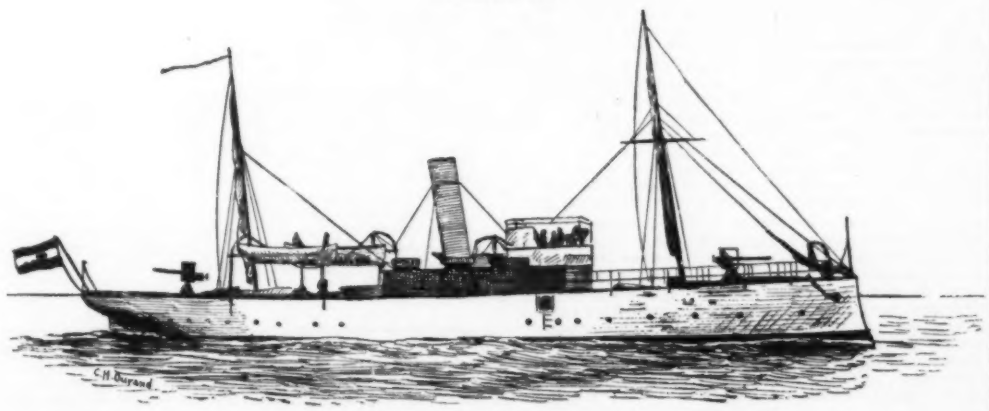
"NUMANCIA."



"NUMANCIA"—AS REMODELED, 1898.



"LEPANTO."



"HERNAN CORTEZ." "PIZARRO." "VASCO NUÑEZ DE BALBOA."

a case of gross recklessness. He visited some works in which the impregnation of the rubber with benzene was effected on fifteen machines, each with an area of more than fifty square feet, the plates being heated by high pressure steam. As the machinery was working day and night the space was saturated with benzene vapor, and yet five arc lamps were burning in it. It is not stated whether the arc lamps are burning continu-

THE HOME MODIFICATION OF MILK.*

By WILLIAM L. BANER, M.D.

WHILE it is generally agreed that percentage feeding is the most rational and scientific method of nourishing infants unfortunate enough to be deprived of their natural supply, it must be admitted that many physicians refuse to think in percentages. The mixture which they direct to be put into the nursing bottle may be practically the same as if it had been prescribed with relation to the actual amounts of fat, sugar and albuminoids, and the child may thrive equally well; but the fact remains that they are sailing without a compass, and are really not so well equipped for avoiding rocks and shoals and meeting in a rational manner the various and varying conditions of infant growth. Of course, the percentage idea is comparatively new, and has not as yet been so simplified as to make percentage thinking easy as applied to home mixtures. Moreover, before the Academy of Medicine, last year, Dr. Rotch, who has been the foremost advocate of modified milk, distinctly discouraged home modifications in general; and yet it is by home modifications that the vast majority of bottle babies always have been fed, and always will be till we arrive at absolute Bellamyism. Dr. Rotch's present position seems to amount practically to this: Percentage thinking is the mariner's compass of infant feeding; but, no laboratory, no mariner's compass. In his book, however, he publishes a series of formulæ for home use, which will be referred to later.

To be sure, a man cannot actually think in percentages if he is hampered by the doubt as to whether he is going to be able to produce his percentages with the few set mixtures which he remembers or carries in his notebook. On the other hand, comparatively few are able or willing to avail themselves of the services of the laboratories, both because of the great expense involved and of the perfectly natural objection to a patented food. I do not want to be misunderstood as criticising Messrs. Walker, Gordon and Waterhouse for patenting whatever they may have invented. As business men, they naturally want to protect themselves in every possible way. Moreover, great credit is due them for the formulation of the percentage idea. It is, however, a very intangible thing to base a patent upon, and, besides this, I think they would have had a heartier support from the profession if they had depended on the merit of their product. While much credit is also undoubtedly due to Dr. Rotch for explaining and advocating modified milk before so many medical bodies all over the country, I must confess that I cannot agree to the statement made by him, in a letter on file in the Patent Office, in which he says that it is of the greatest importance to physicians, and a question of many babies' lives being saved, that this patent should be granted. It seems to me that the only effect of the patent, so far as concerns the babies, will be to restrict the use of the product and to prevent the improvements which always come with competition. Any dairyman who wanted to compete in this field would of necessity have to furnish milk of exceptional purity and freshness properly guaranteed. It would be part of his necessary stock in trade, without which he would lack customers, and this simple economic fact throws more safeguards around the nursing bottle than does the payment of royalties to certain patentees.

Percentage feeding has been criticised on the ground that in the present state of our knowledge we are not sufficiently conversant with the need for and effect of the various food elements to be able to say just what modification will suit each particular case. This is true to a certain extent, and, moreover, we never shall be able to until we make a start in that direction on a scientific basis. After a few years of percentage thinking, our stock of knowledge regarding sugars, fats and albuminoids will have increased. Our principal need at the present time is greater simplicity in the methods of connecting percentage thinking with home mixing. There is in reality nothing complicated about the subject, and the babies whose food is mixed in the kitchen by the nurse are as much entitled to be steered by compass as are the favored few whose food comes from the laboratory.

The formulæ for home use which Dr. Rotch gives in his book are made from ten per cent. gravity cream and the under milk. Dr. Westcott, of the University of Pennsylvania, points out that, unfortunately, in calculating these formulæ the two per cent. of fat remaining in the under milk has been overlooked, causing an error in the percentages which reaches in Table 80 a variation giving nearly one-third more fat than intended. This does not seem to me to be a very serious defect—not so serious as the tedious nature of the actual process involved on the part of the nurse and the absence of any key to the situation for the use of the physician except reference to the set mixtures of the text book—an absence which conduces to the memorizing of two or three mixtures and the ignoring of a great principle.

Dr. Holt, in his excellent book, has given us a system which consists of diluting in various proportions either whole milk, eight per cent. cream or twelve per cent. cream, with one or other of some five different percentage solutions of sugar. This method is ingenious, but, after a careful study of it, I have come to the conclusion that in actual practice it is burdensome. When giving directions to mother or nurse, it is intended that this method be used merely as a means of calculating the amounts of commercial milk, cream and sugar which are to be mixed with a certain amount of water, and the calculation involved is often quite confusing.

One of the recent contributors to this subject is Dr. Westcott, of Philadelphia. Realizing the great advantage and need of working formulæ for milk modification, Dr. Westcott has given us some in the Archives of Pædiatrics for January, 1898. These formulæ are of interest, but I fear are not adapted for general use, as they involve the considering of two unknown quantities in each equation, necessitating the assuming of trial values for one unknown quantity and working through. If not right, other values are assumed and worked through again, and so on. In short, they are rather a means of proving the correctness of assumed amounts than genuine working formulæ. In his equa-

* Read before the Society of the Alumni of the City (Charity) Hospital, February 9, 1898.—From The New York Medical Journal.

tions, moreover, Dr. Westcott assumes 3·90 per cent. as the average proteid mean between whole milk and twelve per cent. cream. By striving for such a minute exactness he loses the great advantage and simplicity which come from regarding cream as simply a superfatted milk, as is done by Holt in figuring his formulæ. Moreover, I have great doubt if there is actually any gain in accuracy. I am aware that Dr. Rotch publishes in his book a table which seems to show that there is a slight percentage of loss of proteids in cream as compared with the whole milk. The extraordinary part of this analysis is, however, that there is no corresponding proteid gain in the separated milk, which still contains four per cent. of proteids—an apparent loss of proteids somewhere. Blyth, on the other hand, claims for cream a slight increase in albuminoids over milk, from their tendency to "mechanically adhere to the fat." The probable truth seems to be that the presence of high percentages of butter fat makes the quantitative estimation of the proteids less easy. The practical fact is that it is undoubtedly better to disregard a variation amounting to so small a fraction of one per cent., as Dr. Holt does.

It seems to the writer that the great desideratum in any method for home modification is simplicity. In choosing the formula to be used for any particular case, the mind of the physician must be unhampered by any thought as to whether he is going to be able to produce just the mixture to give that formula. He must be able to decide on his percentages just exactly as if his prescription were to be filled at the laboratory. Having done his thinking in percentages, he must then have some simple method for putting his thoughts into terms of ordinary commercial articles. The following method is submitted as an effort in this direction. It is based on the use of ordinary good cow's milk, containing on the average four per cent. of fat and four per cent. of proteids, in accordance with Dr. Rotch's analysis (Analysis No. 46). Both Dr. Rotch and Dr. Holt base their modifications upon this analysis. It is also based on the fact that cream is simply a superfatted milk, containing practically the same amount of proteids as milk itself. Either of the ordinary creams recommended by Dr. Holt in his book may be used—that is, sixteen per cent. gravity cream or twenty per cent. centrifugal cream; or, if preferred, the twelve per cent. gravity, as recommended by Dr. Westcott, may be used. By Dr. Westcott's method a quart of good milk is left in ice water for six hours, after which the top six ounces will be twelve per cent. cream. This method, like Dr. Rotch's, has the advantage of insuring the freshness of the cream, and the emulsion is probably more perfect than at present obtains with centrifugal cream. They both have the same tedious procedure for the nurse, however, and both he'p to postpone that greatly to be desired day when milk dealers will furnish fresh creams of known percentage. It would be easy for them to do so to-day, all that is needed being the demand.

It will be convenient to first explain this method of calculating as used with sixteen per cent. cream—this being the percentage in ordinary skimmed cream, and also the centrifugal percentage used in the laboratories—and then show the slight changes of equation necessary for using with other creams. If these equations sound and look complicated, they are, in reality, very simple. They are submitted merely as working formulæ, and without detailed explanation. The mathematically inclined will see the explanation at a glance.

Having determined upon the formula which we desire to prescribe, and upon the number of ounces of the mixture which will be needed, we first estimate the cream by the following simple procedure: Subtract the proteid percentage from the fat percentage and multiply the remainder by one-twelfth the total number of ounces of the mixture. This gives the cream in ounces. Next, to estimate the milk, multiply the quantity of the mixture by the proteid percentage and divide by four. This gives the total milk and cream. Subtract from this the amount of cream, as already estimated, and the remainder will, of course, be milk. It is hardly necessary to mention the water, as it is self-evident that the entire mixture, less the milk and cream, will be water. We now come to the question as to how much dry milk sugar must be added to give the desired sugar percentage. Dr. Westcott in his formulæ arrives at it in this way: He multiplies the sum of the milk and cream by an assumed average mean percentage of the sugar in undiluted milk and cream mixtures. This mean he assumes to be 4·40 per cent. The product thus obtained he subtracts from the product obtained by multiplying the total quantity of the mixture by the desired sugar percentage, and then divides this remainder by 100. This is complicated in practice, and the mean allowed seems too high. Rotch (Analysis 47) places the sugar in good cow's milk at 4·30 per cent.; in cream, at four per cent. A formula which would represent very accurately the additional sugar needed would be this: Subtract from the desired sugar percentage seventeen-sixteenths of the proteid percentage. Multiply the remainder by total quantity of mixture and divide by 100. This would be considering 4·25 per cent. as the sugar mean between milk and cream After carefully going over the matter, however, and working out all the generally used percentages, it is found that the following more simple equation gives results which agree quite accurately with the Holt formulæ, and are practically correct: Multiply the difference between the sugar and proteid percentages by the quantity of mixture and divide by 100.

We have then a simple formula, in known terms, for each ingredient of the mixture. The following table will give a better idea of the principles involved than a verbal description:

Formulæ for Determining the Amounts of Cream, Milk, Water and Dry Milk Sugar Required to Make any Desired Quantity of Mixture to Contain Given Percentages.

Given: Quantity desired (in ounces) = Q.
Desired percentage of fat = F.
Desired percentage of sugar = S.
Desired percentage of proteids = P.

To find (in ounces):

$$\text{Cream (16 per cent.)} = \frac{Q}{12} \times (F - P)$$

$$\text{Milk} = \frac{Q \times P}{4} - C$$

$$\text{Water} = Q - (C + M)$$

$$\text{Dry milk sugar} = \frac{(S - P) \times Q}{100}$$

If twenty per cent. centrifugal cream is used, the denominator of the cream formula will be 16 instead of 12. If twelve per cent. cream is used, it will be 8 instead of 12.

Examples.—Suppose we want forty ounces of a mixture to contain four per cent. of fat, seven per cent. of sugar and two per cent. of proteids:

$$\text{Cream} = \frac{40}{12} \times 2 = 6\tfrac{2}{3} \text{ ounces.}$$

$$\text{Milk} = \frac{40 \times 3}{4} - 6\tfrac{2}{3} = 13\tfrac{1}{3} \text{ ounces.}$$

$$\text{Water} = 40 - 20 = 20 \text{ ounces.}$$

$$\text{Sugar} = \frac{5 \times 40}{100} = 2 \text{ ounces.}$$

The directions to the nurse would then be to dissolve two ounces of milk sugar in twenty ounces of water, add 13⅓ ounces of milk and 6⅔ ounces of cream (skimmed), and divide into as many bottles as desired. The question of adding limewater or other alkali, and the question of pasteurizing or sterilizing, would have to be considered, but do not come within the scope of this article.

As another example, suppose we want twenty-four ounces to contain four per cent. of fat, six per cent. of sugar and 1·5 per cent. of proteids:

$$\text{Cream} = \frac{24}{12} \times 2{\cdot}50 = 5 \text{ ounces.}$$

$$\text{Milk} = \frac{24 \times 1{\cdot}50}{4} - 5 = 4 \text{ ounces.}$$

$$\text{Water} = 24 - 9 = 15 \text{ ounces.}$$

$$\text{Milk sugar} = \frac{4{\cdot}50 \times 24}{100} = 1{\cdot}08 \text{ ounces (practically 1 ounce).}$$

These examples will serve to show the ease of the calculations. It should, of course, be remembered that very high fat with very low proteid percentages cannot be made with twelve per cent., sixteen per cent., or possibly even with twenty per cent. cream. It can readily be seen that with sixteen per cent. cream it is only possible to make the fat percentage four times the proteid; with twenty per cent., five times, etc. This is merely mentioned as a possible contingency, it not being at all probable that any one will try unusual and impossible formulæ and blame these equations for bringing out the milk with a minus value. For instance, if we try to make twenty-four ounces of mixture to contain four per cent. of fat, six per cent. of sugar, and only 0·5 per cent. of proteids, we find that the sixteen per cent. cream necessary for the fat percentage would be seven ounces, but the milk equation shows that only three ounces of either milk or cream are allowable without overdoing the proteids.

A great advantage of these equations, it will be observed, is the ease with which odd amounts of mixture can be calculated. People have an annoying habit of asking how to make up odd numbers of ounces, and when the tables in the books give directions for making eight, twenty-four or thirty-two ounces, it is not always easy to figure out for thirty-five ounces. For instance, a lady came to me recently with the copy of a laboratory prescription which called for fifty-five ounces of milk containing certain percentages. Her child had been doing well, and she did not want to make any change in the general character of the food, but could no longer afford to pay the twenty-one dollars per month. Without these working formulæ the calculation would have been tedious. It should also be noted that these formulæ can be used backward for calculating the percentages where the quantities of milk, cream, etc., are known, the proteid percentage being first found from the milk formula to avoid two unknown quantities.

The question of how to obtain definite percentage creams is a very important one. As is well known, the standard at present in this city is this: Cream is anything the dealer can get the customer to accept as cream, whether the fat is four or forty per cent. The very thick creams, as was pointed out by Dr. Huddleston, are old creams which have been kept packed in ice for a long time—often for ten days or two weeks—and which are thickened by bacterial action. Some customers demand such cream. A neighbor of mine, one of the medical board of the City Hospital, changed milk dealers because the cream was not thick enough. Repeated analyses showed that the fat percentage was actually unusually high in the cream to which he objected. Most of the cream in New York is at least seventy-two hours old, but there is no reason why centrifugal cream should not be delivered as fresh as milk, and it could easily be made of any desired fat percentage. In fact, some dealers are beginning to supply definite percentage creams, and a demand for them will bring many more into line. My own experience with cream from first-rate dairies has not been as unfortunate as that which Dr. Rotch related to the academy last year. Dr. Rotch advised a certain New York dealer that he wanted a constant cream for a specific purpose, and yet the fat percentage varied between ten and twenty-eight per cent. on different days. I have found the cream from good dealers to vary somewhat on different days, but not materially. Occasionally, however, there may be a fluctuation from the general average. A dairyman who makes much cream will use just about the same number of quarts of milk each day to produce a quart of cream.

A very important subject in connection with milk modification is the question of the proteids. There is a general tendency at present to cut down the total albuminoids to a very low figure in order to avoid casein indigestion. In our efforts to attenuate the curd, we must not forget that we are diluting the albumen as well as the casein, and that the proteids constitute by all odds the most important element of the milk, the very protoplasm of the human machine being formed of nitrogenous matter. The question as to whether the cereals when added to milk aid the digestion of curd is answered in the negative by Dr. Rotch. He finds in a series of test-tube experiments that a finer curd is caused by dilution with hot water than by adding cereals. A fairer test would be to compare the curds in a specimen simply diluted with those in one both dilute and with cereal added. However, experiments of this kind can prove very little, as it is by no means certain that there is a correlation between size of clot and its digestibility. The power of casein to occlude other substances is very remarkable, and it is possible that the cereal, whatever it may be, is so intimately mingled with the clot as to provide numberless points vulnerable to the digestive juices, though invisible to the eye. A lump of sugar may look larger than a piece of taffy, and yet dissolve much more quickly. In practice we certainly do find that an infant can sometimes take a heavier milk if some cereal food be added. This question is very interesting, and will well repay thorough investigation. Certainly it cannot be settled conclusively with such simple test-tube experiments. The occlusive power of casein is easily shown with coloring matters. If milk be colored with vegetable carmine and acetic acid added, the color will be sought out and included by the clot, leaving the whey colorless. Of course, other substances not so easily visible are treated in the same way. It will be remembered that a year or so ago Dr. Delavan pointed out the usefulness of rennet for disguising the taste of iodide of potassium—an instance of occlusion. Certainly these facts suggest a possible field for research.

While these considerations seem to me full of interest, I do not want to lose sight of the main idea of these remarks, which is a plea for more general percentage thinking, and an attempt to furnish an easier road between it and the commercial articles in the hands of the nurse or mother.

TABLE OF WIND PRESSURES ADOPTED BY THE ENGLISH NAVY.

THE following table, taken from London Engineering, was prepared by Mr. J. T. Conor, engineer-in-chief of the Portsmouth Dock Yard, and it gives the figures adopted by the English navy for the pressure of the wind due to various velocities. As the velocity table is in English knots, we have added a column of English miles.

TABLE OF FORCE OF WIND.

Nautical No.	Name of wind.	Velocity—Knots.	Velocity—Miles.	Force per square foot in pounds.
1.	Light air	1	1·15	0·0067
		2	2·30	0·027
		3	3·45	0 060
2.	Light wind	4	4·60	0·107
		5	5·75	0·167
3.	Light breeze	6	6·90	0·240
		7	8·05	0·327
4.	Moderate breeze	8	9·20	0 427
		9	10·35	0·540
5.	Fresh breeze	10	11·50	0 667
		11	12·65	0·807
		12	13·80	0·960
		13	14·95	1·13
		14	16·10	1·31
6.	Strong breeze	15	17·25	1·50
		16	18·40	1·71
		17	19·55	1·93
		18	20 70	2·16
		19	21·85	2·41
		20	23·00	2·67
7.	Moderate gale	22	25·30	3·23
		24	27·60	3·84
8.	Fresh gale	26	29·90	4·51
		28	32·20	5·23
		30	34·50	6·00
		32	36·80	6·83
9.	Strong gale	34	39·10	7·71
		36	41·10	8·64
10.	Heavy gale	38	43·70	9·63
		40	46·00	10·7
11.	Storm	45	51·75	13·5
		50	57·50	16·7
12.	Hurricane	60	69·00	24·0
		70	80·50	32·7
		80	92·00	42·7
		90	103·50	54·0
		100	115·00	66·7

This table seems to be based on the old one first published by Smeaton in 1759. It is far from being correct as expressing the relation between the velocity and the force of wind, as was shown in our issues of July 5, 1890, and February 9, 1893. Smeaton's table corresponds to the formula $P = 0{\cdot}005\ V^2$, in which P is the pressure per square foot and V the velocity in miles per hour. Modern experiments have shown that the coefficient 0·005 is probably much too high, the results obtained generally varying between 0·003 and 0·005, and as low as 0·0014 has been obtained.

Acetylene and oil gas for train lighting is being introduced on the state railways of Prussia, after a series of tests, says Engineering News. The mixture used is 1 part acetylene to 3 parts of oil gas; the illuminating power of the latter being thus increased 300 per cent. A flame consuming 27 liters of the mixture per hour produces a 16-candle power light. No change is required in the present manufacturing methods or in the oil gas appliances. As a model for the installation at other points the new method will be first applied at the Grunewald Station, near Berlin, where, at 10 hours per day, the minimum annual consumption is 21,180,000 cubic feet of gas. At the present time 127,000,000 cubic feet of Pintsch oil gas is annually consumed on the Prussian railways. On this basis 31,800,000 cubic feet of acetylene gas will be required per year, requiring for its production 3,000 tons of calcium carbide.

ENGINEERING NOTES.

The royal administration of the Swedish state railways invites civil engineers or other interested parties to a competition of designs for the arrangement of new railroad stations, junctions, etc., for the city of Stockholm. The first prize is to be 12,000 Swedish crowns (about $3,230); the second, 8,000 Swedish crowns (about $2,150); and the third, 4,000 Swedish crowns (about $1,075). The time for competition will expire at noon on August 31, 1898. Particulars concerning the nature of the work will be furnished by Mr. August Peterson, Le Droit Building, corner of F and Eighth Streets, Washington, D. C. Security to the amount of $13.50 for the use of the drawings in this competition is required, but this will be refunded when the drawings are returned.

The first road, we believe, says The Railway Gazette, to equip a complete bicycle baggage car and put it to practical use is the Long Island Railroad Company. It put into service recently a car which is fitted with specially made bicycle holders placed in a row a few inches apart along each side of the car, while regular rows of hooks attached to the ceiling hold an equal number of wheels. In this manner, 144 bicycles are conveniently and safely stored away in a car only 49 feet long. No part of the wheels touches the wall or ceiling, and the wheels are held so firmly that sudden stops or starts cannot dislodge or bump them. A passageway is left in the center of the car. Six more cars are being similarly equipped and will soon be put in service on this road.

Coal records are to form the basis of the relative standing and promotion of the enginemen on the Wabash Railroad, according to a circular, a copy of which has been received from Mr. George M. Burns, fuel agent of the road, says The American Engineer and Car Builder. After announcing this fact, the circular explains the use of a new coal ticket and urges men to exert themselves to stand at the head of the list, and shows the importance of careful attention to the admission of air under the grates, continuing as follows: "Engineers should use good judgment in the use of the injector, as economical firing cannot be done unless water is supplied to the boiler regularly. Attention is also called to the importance of using the feed water heater, as by that means warm water is supplied to the boiler, thus saving considerable heat energy. Water in tenders should be heated to from 70 to 90 degrees before leaving terminals. The injector heaters should be used to prevent popping off and at the same time to assist in heating water in the tender." The loss of fuel by blowing at safety valves is troubling many mechanical officers, and they will probably be glad to have attention again called to the possibility of utilizing this heat in the feed water.

A statement prepared by the Board of Naval Officers recently appointed to investigate the subject of spontaneous ignition of coal summarizes the supposed causes of combustion in eleven out of twenty fires reported on war vessels in the past three years, says The Army and Navy Journal. The "Petrel's" upper bunker caught fire two years ago at a point 18 inches from the boiler, prsumably from the great heat, 200°, in the space between boilers and bunker and to the absence of ventilation, as the ship had been battened down for a week. According to the New York Sun, the report says that wet comax coal had been stowed in this bunker repeatedly without any trouble, as long as there was some exit for gas. A fire in the lower bunker of the "Olympia" was believed to be due to proximity of the boilers and feed tank. The back head of the boiler was about 8 inches from the bunker, but the feed tank adjoined it. Another fire later on the same ship was reported to be due to the proximity of the upper bunkers to the steam pipes and boilers. A fire on the "Cincinnati" was due to bad bunker ventilation. The heat in this instance was so great that it charred the wood around the shell room in adjacent magazine, which was separated from the bunker by a single bulkhead only. Fire in the "Indiana's" bunkers was due to the location of the bins, which were so placed that anything short of anthracite might ignite. A fire on the "Albatross" became so intense that redhot coals nearly burned the floor of the bunkers through. In a number of other instances fire occurred, but practically all the investigations showed that the coal had ignited through proximity of the bunkers to the fireroom or steam boilers or pipes.

A well informed correspondent writes The Engineering and Mining Journal from London: As far back as 1857 the Rev. J. B. Reade made some extremely interesting experiments on the solubility of gold in the metallic state and as it exists in different ores. Ten years previously he had demonstrated that if a few drops of liquor ammonia be added to 20 or 30 grains of iodine and the compound slightly heated, the result is an ammoniacal solution which is an instantaneous solvent of gold leaf. This solution, he said, when saturated with gold, yields upon spontaneous evaporation four-sided prismatic crystals of ammonia-periodide of gold, which have very much the same color as iodine. At a high temperature ammonia and iodine are given off and metallic gold remains. For several years Mr. Reade continued his researches and finally, last year, in 1897, a paper was published from which we extract the following information: "Some caution is required in forming a solution of iodine in ammonia, but with ordinary care to secure a large excess of iodine, which dissolves periodide of nitrogen if formed, the explosion of this terrible compound may be avoided. The best method is to place 50 or 60 grains of iodine in an evaporating basin, to warm it until the vapors arise, and then to add a few drops of liquor ammonia, which will be immediately charged with a large excess of iodine in solution. Gold leaf, in this solution, instantly turns black (or purple, if the solution is weak) and immediately dissolves, like sugar in water. If a drop or two of the iodine solution is spread on a piece of glass and two or three square inches of gold leaf dissolved in it, a very slight application of heat will cause a rapid crystallization in the arborescent form. The solution of iodine in ammonia may also be successfully used in separating gold from ores when the percentage of gold is very small. From a commercial point of view, this solution might be more available than mercury, and the iodine could be easily collected and used for further experiments."

MISCELLANEOUS NOTES.

An expedition in search of Andrée is about to leave Stockholm for Siberia, the cost being borne by the Swedish Geographical Society.

An attempt to cross the Alps in a balloon, starting from the Italian side, will be made next summer. The intention is to keep at a height of 15,000 feet as long as possible, and to take photographic views and make scientific observations during the passage.

According to a report from United States Consul-General DuBois, the mint of Switzerland coined in 1897 a total of 2,886,700 pieces. Of these 400,000 were 20-franc gold pieces. The remainder were bronze pieces, as follows: 500,000 of 20 centimes; 500,000 of 10 centimes; 500,000 of 5 centimes; 486,700 of 2 centimes; 500,000 of 1 centime. The one centime coin is worth only one-fifth of a cent in United States money.

Berlin was the scene of a collision between a horse car and a balloon recently. A captive military balloon broke loose during a squall, and drove across the Tempelhof field, dragging with it the soldiers who were holding it. On reaching the street, though its speed was checked by its carrying away some telegraph wires, it hit a horse car violently enough to upset it with its passengers. Two of the soldiers who held on were badly hurt.

The cinematograph and the Dussaud phonograph will be combined in the exhibition to be made at Paris in 1900 by the Compagnie Générale Transatlantique. The idea is to represent on a full scale the different scenes of maritime life as experienced by the fleets of the company, while the phonographs will reproduce the sounds. Careful preparations are being made by the officers and electricians of the company, and it is safe to say that this feature of the exposition will score a popular success.

The British Patent Office records show that the modern typewriting machine is not such a modern innovation as is usually supposed, says The Mechanical Engineer. In 1714 James Mill took out a patent for a machine in England to "write in printed characters." Exactly a hundred years later Bain and Wright, both Englishmen, invented writing machines; another inventor, Thurber, of Worcester, attempted a perfection of the same idea; while as recently as 1851 a M. Foucault, of Paris, patented a very elaborate writing machine, the model of which was shown in the Great Exhibition.

Recently before the Philosophical Society at Glasgow, Dr. Magnus Maclean read a paper on "Lord Kelvin's Patents." There were, he said, altogether 47 patents from February 20, 1858, to September 28, 1896—a period of 38 years. All of them could be conveniently classified under four heads: A. Patents relating to improvements in electric telegraphic apparatus. B. Patents relating to improvements in navigational apparatus. C. Patents relating to improvements in generating, regulating, measuring, recording and integrating electric currents. D. Improvements in valves for fluids. Under the first head (A) there are 11 patents. Under the second head (B) there are 10 patents. Under the third head (C) there are 24 patents. Under the fourth head (D) there are two patents. There are up to September 28, 1896, 47 patents.

With the consent of the Liverpool Corporation, the Pluto Hot Water Company, of London, have just erected in that city a machine for the supplying of hot water. In appearance this latest development of the automatic supply system is that of a large lamp post. At the base is a cistern capable of holding fifty gallons, and this water is heated by a series of coils which descend from the gas jets at the top of the structure. By placing a halfpenny in the slot at the base of the machine a gallon of pure boiling water may be obtained. It is intended to keep the gas jets burning night and day, thus insuring a constant supply. Several of these machines have been fitted in the corporation dwellings in the City of London, and the company erecting them have obtained powers to adopt the system so as to supply hot drinks, such as coffee, cocoa, etc.

An aspirant to fame has contributed to a technical contemporary his proposed method of raising the United States battleship "Maine." He proposes to begin at the conning tower by making the top airtight. On a vessel alongside he would place air-pumping equipment, connecting with the top of the tower. If the ship is now in only 30 feet of water, it will take but a pressure of 15 pounds to the square inch to force the water down. Then, as the pressure drives back the water, and the second deck is reached, it can be tied to the upper structure if the required pressure become too great. In this way the divers will never be working in water deeper than the distance between two decks, and means can easily be taken for their safety. By keeping up the air pressure, which need not be over 20 pounds to the square inch, even if the ship is 40 feet below the surface, the water is finally ejected, the torn parts of the hull are planked over, and the ship rises by her own buoyancy, just as naturally as she floated when launched. In short, this plan proposes to make the water go out of the same hole that it came in at.

There is a coincidence in a prolonged drought and in an increased mortality among the negroes in Charleston, S. C., as also a connection between the two. The News and Courier of that city says: There has been little rain in that section for forty days or more, with the result that many of the water cisterns are empty. The colored people in the city depend largely for their water supply on water caught in barrels from the roofs of their houses. This is vile water under the best conditions, daily becoming worse when the supply is not renewed. With the failure of this the negroes, having no knowledge of hygiene, resort to the surface wells, which, if not worse, are as bad as the depleted cisterns. As a result, the health officer's report of the number of deaths among the negroes for the week ended on Saturday last was twenty-five, the deaths among the better situated whites for the same period being only two. An effort to remedy the conditions is being made in the establishment of artesian drinking fountains. Where these have been placed the sickness and death rate have been greatly reduced, and The News and Courier calls for their general introduction in the negro quarter.

SELECTED FORMULÆ.

Fast Black Stamping Ink.—According to the Pharm. Zentrh., a fast stamping color for linen, cotton and woolen fabrics is prepared as follows: "Dissolve five parts of nitrate of silver in ten parts of spirits of salammoniac, and prepare another solution of five parts gum and seven parts soda in twelve parts water. Mix both solutions and heat carefully in a porcelain dish on the water bath until the liquid has become black. This will render the stamped signs visible at once, but the fastness will ensue in the fiber only during the drying." This argentic stamping color is absolutely fast to washing and likewise to light.

Annealing Steel.—More steel is injured, and sometimes spoiled, by over-annealing than in any other way. Steel over-heated in annealing will shrink badly when being hardened; besides, it takes the life out of it. It should never be heated above a low cherry red, and it should be a lower heat than it is when being hardened. It should be heated slowly, and given a uniform heat all over and through the piece. This it is difficult to do in long bars and in an ordinary furnace. The best way to heat a piece of steel, either for annealing or hardening, is in red hot, pure lead (says Mr. Pratt, of the well known firm of Pratt & Whitney). By this method it is done uniformly, and one can see the color all the time. The firm do some heating for annealing in this way, and simply cover up the piece in saw dust and let it cool there, and get good results.

The Perfect Mouth Wash.—A thoroughly antiseptic mouth wash is almost impossible, for several reasons, which a writer in The American Journal of Dental Science (Ch. and Dr.) puts thus: (1) Owing to dilution with saliva, any drugs sufficiently powerful to destroy germs are rendered almost, if not entirely, inert; (2) the short time of exposure while rinsing the mouth is insufficient for antiseptics of slow action, especially when particles of solid food are impacted in the teeth; (3) danger of injurious effects on the tooth structure; (4) unpleasant tastes are objectionable. Soap, applied with a brush, is one of the best cleaners, because its alkali dissolves the mucus. The following is a good preparation:

Listerine	3 ounces.
Glycerine	3 "
Carbolic acid	2 drachms.

Dilute one-half teaspoonful in one-third glass of water. Hold in the mouth and continue the cleansing process carefully by the watch for at least two minutes. This is effective, agreeable to most persons, and valuable by reason of its simplicity, as patients can safely vary the strength in using it from time to time, as the condition may seem to require.—Pharmaceutical Era.

Mounting Herbarium Specimens.—A matter of first importance (says The Pharmaceutical Journal), after drying the herbarium specimens, is to poison them, to prevent the attacks of insects. This is done by brushing them over on both sides, using a camel's hair pencil, with a solution of two grains of corrosive sublimate to an ounce of methylated spirit. In tropical climates the solution is generally used of twice this strength. There are several methods of mounting them. Leaves with a waxy surface and coriaceous texture are best stitched through the middle after they have been fastened on with an adhesive mixture. Twigs of leguminous trees will often throw off their leaflets in drying. This may, in some measure, be prevented by dipping them in boiling water before drying, or if the leaves are not very rigid, by using strong pressure at first, without the use of hot water. If the specimens have to be frequently handled, the most satisfactory preparation is Lepage's fish glue, but a mixture of glue and paste, with carbolic acid added, is used in some large herbaria. The disadvantage of using glue, gum or paste is that it is necessary to have some of the leaves turned over so as to show the under surface of the leaf, and some of the flowers and seeds placed loose in envelopes on the same sheet for purposes of comparison or microscopic examination. Another plan is to use narrow slips of gummed, stiff but thin paper, such as very thin parchment paper. These strips are either gummed over the stems, etc., and pinched in round the stem with forceps, or passed through slits made in the sheet and fastened at the back. If the specimens are mounted on cards and protected in glass frames, stitching in the principal parts with gray thread produces a very satisfactory appearance.

Waterproof Enamel Shoe Dressing.—The Era Formulary gives the following:

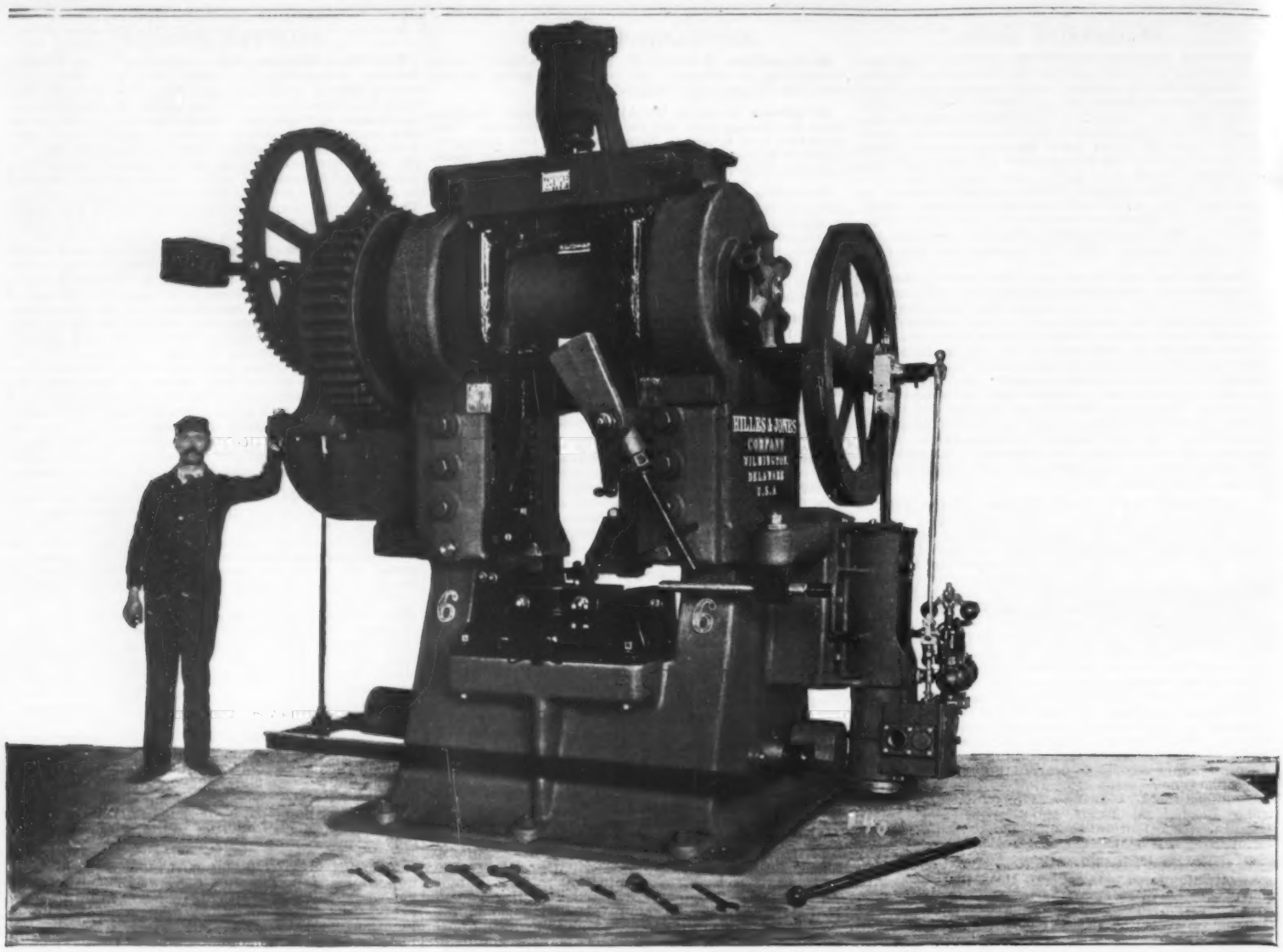
1. Caoutchouc	100	parts.
Petroleum	100	"
Carbon disulphide	100	"
Shellac	400	"
Lampblack	200	"
Oil lavender	10	"
Alcohol	2,000	"

Upon the caoutchouc in a bottle pour the carbon disulphide, cork well and let stand a few days, or until the caoutchouc has become thoroughly gelatinized or partly dissolved. Then add the petroleum, oil of lavender and alcohol, next the shellac in fine powder, and heat it to about 50° C., taking care that as little as possible is lost by evaporation. When the substances are all dissolved and the liquid is tolerably clear, add the lampblack, mix thoroughly and fill at once into small bottles.

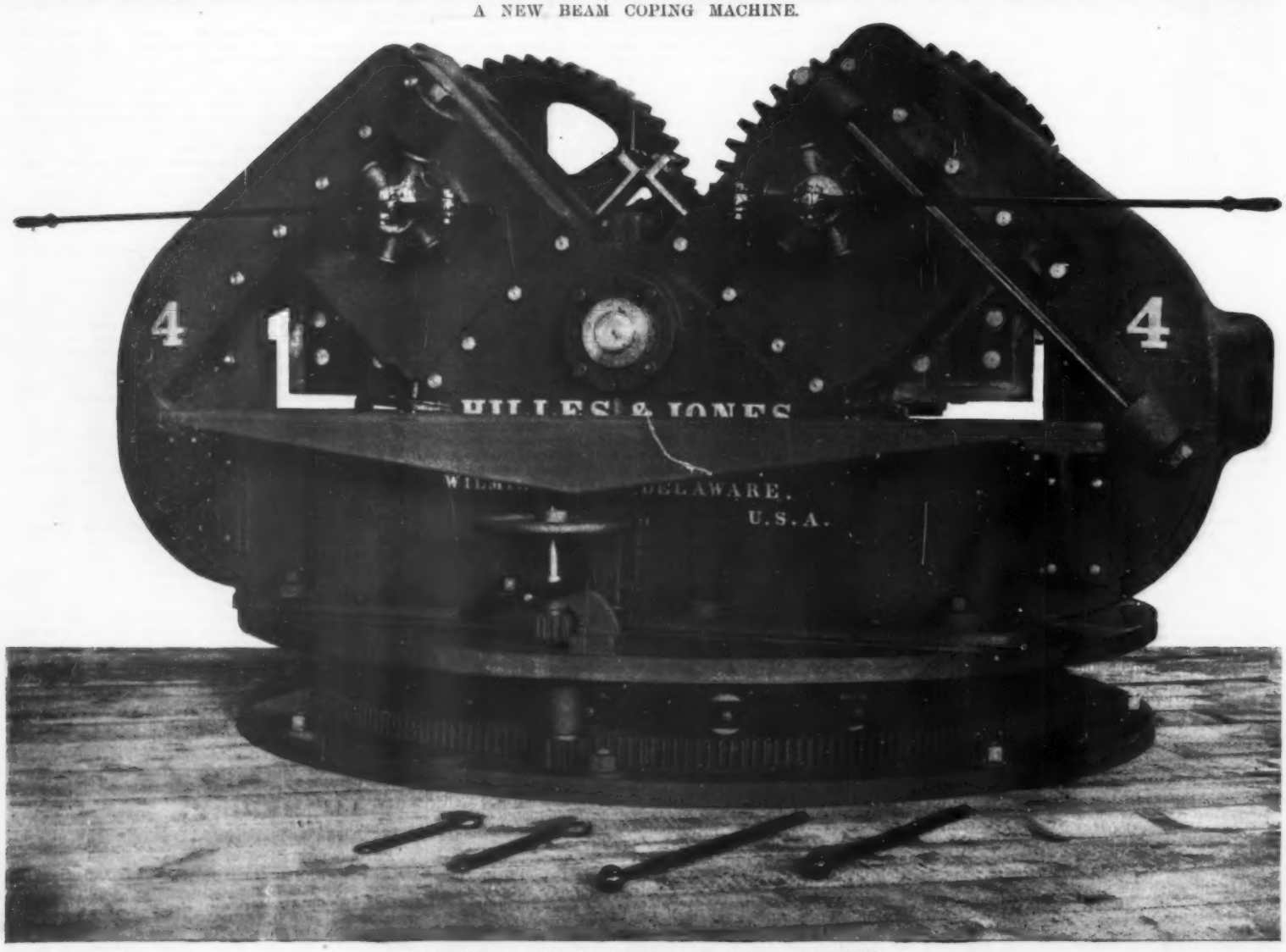
2. A waterproof blacking which will give a fine polish without rubbing, and will not injure the leather:

Beeswax	18	parts.
Spermaceti	6	"
Turpentine oil	66	"
Asphalt varnish	5	"
Powdered borax	1	"
Frankfort black	5	"
Prussian blue	2	"
Nitro-benzol	1	"

Melt the wax, add the powdered borax and stir till a kind of jelly has formed. In another pan melt the spermaceti, add the asphalt varnish, previously mixed with the oil of turpentine, stir well, and add to the wax. Lastly add the color previously rubbed smooth with a little of the mass The nitro-benzol gives fragrance.—Pharmaceutical Era.



A NEW BEAM COPING MACHINE.



A POWERFUL DOUBLE-ANGLE SHEARING MACHINE.

POWERFUL MACHINES FOR WORKING STRUCTURAL IRON AND STEEL.

THE enormous development in the employment of structural iron and steel, within a very recent period, has afforded a corresponding stimulus to the skill and ingenuity of our machine tool manufacturers in the making of the powerful machines needed for the economical handling and shaping, the exact fitting, etc., of the tough iron and steel plates, bars and beams which modern construction calls for. To say that this work is now done with about the same facility with which the carpenter, with the saw, plane and chisel, would properly shape and fit the parts of a structure of the past generation, is hardly an exaggeration. And as the introduction and rapid extension of the use of iron and steel in bridges, buildings, etc., has been a field in which the United States has led the way for the world, it follows that our inventors and manufacturers should lead the way in the perfecting of machines for facilitating such work.

In the accompanying illustrations we show two powerful yet most easily operated and highly efficient machines, especially adapted for the working of I beams and angle plates of the largest proportions. The machines are made by the Hilles & Jones Company, of Wilmington, Del., and the standard I beam and channel coping machine represented is furnished with a complete engine for driving mounted on the main frame. One of the most interesting points about the machine is the fact that a bar can be passed entirely through the sliding head, and the flange coped or sheared for any length at any point of the bar, either at the end or any distance from the end. The flange can be cut away in this manner for the whole length of the beam on either side, or simply notched out for the clearance of chords or other purposes. In addition to the ordinary coping knives, there is a separate pair of projecting blades which can be used for trimming off the end of the web of a beam or channel after the flanges have been coped back. With this arrangement the fitting up of such work can be done much more accurately, as the beam can be trimmed off to suit exactly the required place, and have no end motion whatever. The arrangement of stops is very convenient, being self-contained in the die block itself and readily adjusted. The counterbalanced vertical stop, which is shown in the cut with a handle, is used for clamping the beam when the web is being sheared, which is done through a cam motion, so that no time is lost in hunting up wrenches or bolts. The horizontal screw with a handle is used as a gage to regulate the depth of the coping on the web. There is sufficient clearance in the die block to throw the beam around so that the coping of the web is done at right angles to the length of the beam, and beams of large section can therefore be notched down to suit smaller sections framed into them.

There is on this machine an improved adjustable automatic stop, which allows the sliding head to be brought to rest at any desired point of the stroke. This arrangement avoids the necessity for throwing the clutch by hand, it being automatically thrown into gear by means of a weight, this insuring full engagement of the clutch and but very light work on the operator. The counterbalancing of the sliding head is done by means of a cylinder in which either air or steam pressure can be used.

The sliding head is a high carbon steel casting weighing about 5,000 pounds and necessarily stiff and rigid. The die block is also of this material, and is secured to the nose of the machine by tongues at right angles, as well as by through ream bolts, and the clearance cores allow the pieces sheared out to drop in front of the machine in a convenient place for disposing of them. The whole machine is most substantially got up, and every part has been studied out carefully to provide the greatest amount of service with perfect convenience. Floor space required is extremely small for such a tool, and all the wearing surfaces are large and well provided against wear. A large number of these machines is in use in the largest bridge and structural iron works of this country, and they are said to stand up to the work in first-rate shape. The range of the machine is equal to handling all sections of I beams and channels from 5 inches to 24 inches, and the machine can be driven by steam engine as shown, electric motor or pulleys.

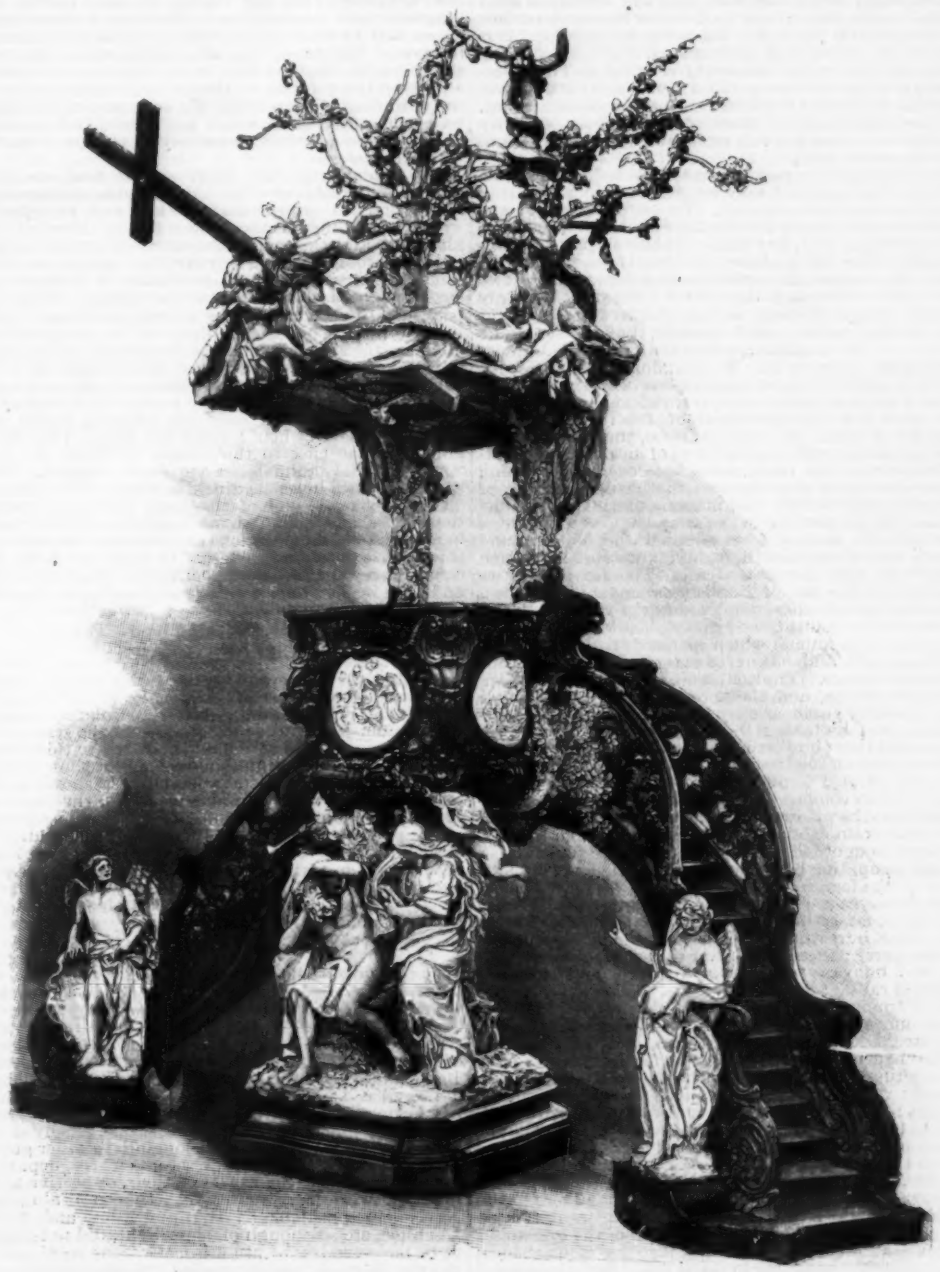
The double-angle shearing machine shown in the illustration is the standard No. 4 double-angle iron shear made by the same company, pulley driven. The engraving illustrates clearly the special features of this type of machine, one of the principal ones being that there are two entirely separate eccentric shafts, sliding heads, etc., so that two gangs of men can work on the tool at one time. Each sliding head is controlled by its separate clutch and this is entirely independent of the other. The table will revolve entirely around, so that the machine will face in any direction desired, and can be clamped fast at that point. This machine has capacity for cutting off 8 inches × 8 inches × 1 inch steel angles without distorting the shape of the piece cut off, and will miter angles to beyond an angle of 45°. The sliding heads and a number of other parts are of cast steel and the whole machine is convenient and substantial in every respect. This tool can also be driven by electric motor, steam engine or tight and loose pulleys. When motor driven, the use of a friction clutch is recommended on the cut gear which is driven from the motor, so that the motor can be started up at full speed and the fly wheel thrown in by means of a friction lever. The wires for driving the motor could be run down through the center of the table and thus have no overhead wiring whatever, leaving the machine entirely free for the passage of cranes. These machines are working in most of the best bridge shops in this country as well as a number abroad, and they are giving excellent results under heavy duty. Larger and smaller machines are built of this same general design.

The Hardie air motor is about to be tried on the street railways of Copenhagen, Denmark. The machinery for a motor car was taken from the United States, and the car is being built in Copenhagen. The car will seat 24 persons inside and 24 on top. It will weigh 26,000 pounds. If it is successful, other cars weighing only 18,000 pounds will be built.

THE PULPIT OF SAINT BAVON CHURCH.

As soon as we become somewhat acquainted with the great Flemish cities of Brussels, Ghent, Liege and Bruges, we are filled with respectful enthusiasm for the wealth of art that they preserve for our admiration. Art in these lively cities, despite the apathy that we are accustomed to think that their inhabitants are possessed of, was not, in olden times, as in our land of feudalism and courtisan nobility, the privilege of a few, but was the appanage of all, and invested the most ordinary objects with grace and beauty. There are many regions in France concerning which the same statement might be made, but they remain disseminated through a vast extent of land, while the small size of the Belgian territory renders the abundance of the marvels that are found, even in the simple market towns of the kingdom, more striking.

The social organization of these cities, which, at an early period, formed themselves into democratic communes, was particularly qualified for giving that impetus to art which has kept them illustrious in the entire world. The general prosperity that accompanied the conquest of civilized liberty in these Flemish communes permitted the artisans, as well as the bourgeois, to embellish their peaceful existence through the ornamentation that they demanded in their furniture, dwellings and public buildings. And we truly find nothing out of taste in an old bourgeois house of Belgium any more than we do in a church or in a city hall.



PULPIT OF SAINT BAVON CHURCH, IN GHENT.

In the majority of the French churches, the pulpit is scarcely anything more than a sort of wooden tub, carefully polished, in which half the body of the sacred speaker disappears as if it had been agreed that he should be prohibited from indulging in great oratorical motions. The same is not the case in Belgium. Many pulpits here are true works of art. That of Saint Gudule, at Brussels, is a masterpiece of sculpture in wood due to the chisel of one of the Van Brughens, and that of the cathedral of Saint Bavon, at Ghent, erected by the sculptor Laurent Delvaux, is, although not possessing the same originality, none the less a work rich in pleasing motives and sumptuous in its nobly decorative ensemble. It is easy to perceive that Delvaux's work is not contemporaneous with the edifice that it contributes toward furnishing.

The church of Saint Bavon, in fact, dates from the period of pointed arches. It sprang from the earth, so to speak, as a magnificent efflorescence of the abbey of Saint Bavon, which was founded by Benedictine monks, was plundered during the revolution, and was bought and demolished stone by stone by a rich citizen of Ghent named Maes, who was assassinated by robbers. It was in this church that, in 1500, Charles V. was baptized. In 1559 it was converted into a collegiate church and cathedral. It was only toward the middle of the last century that Delvaux, by an instrument signed in the presence of M. Van Thiegen, a notary, pledged himself to construct this pulpit of oakwood and Italian marble, with statues, figures of angels, bass reliefs and ornaments, for the sum of 15,000 florins of Brabant.

As may be seen from the accompanying engraving, from Le Magasin Pittoresque, Delvaux executed his order scrupulously. The beyond human and even effeminated æsthetics of his time, so perceptible in the handsome contours of the stairs of his pulpit, did not, however, annihilate his religious sense, although we discover more amiable grace than celestial expression in the countenance and welcoming attitude of his angel, who, with a nobly engaging gesture, is inviting the faithful to give ear to the word of truth. Faithful to the taste for realism and truth that distinguishes the Flemish school, Delvaux has happily guarded himself against allegories and emblems, which might have concurred in the general expression of his work. Having to symbolize the teaching of the Catholic faith, he erected his pulpit upon the scene that is the basis of it—the sin of Adam and Eve, whom he shows driven from terrestrial paradise by two angels, one of whom is provided with a flaming sword and the other with a trumpet whence resounds the menace of the voice of God himself. And, connecting the transgression with its atonement, he has planted two trees (one supporting the coils of the symbolic serpent), which serve as a high back to the pulpit, and has placed triumphantly, in the sumptuously draped dome, the redeeming cross, which is held by somewhat puffy angels that make one think of the cupids employed in draping the beds of the fine ladies of the period. And this mixture of the laughing graces of a time in which the pulpit was emancipating itself with the expression of the austere drama of the redemption gives Delvaux's work a touch of a pleasing anachronism.

This is the most remarkable work of Laurent Delvaux, who, born in 1695, spent nine years of his life in England, where, among many other things, he constructed the mausoleum of John Sheffield, Duke of Buckingham, in the Westminster Cathedral. After a trip to Italy, he stationed himself at Nivelles, where he died in 1778, overwhelmed with honors by Prince

Charles of Lorraine. He has left the reputation of being a conscientious and correct master in whom a want of inspiration was compensated for by a sincere love for his art.

ANIMALS UNDERGROUND.

AN interesting find of buried treasure has just been credited to a mole. Coins were seen shining in the earth of a freshly cast up molehill at Penicuick, near Edinburgh, and a search showed that the mole had driven his gallery through a hoard of ancient coins of the date of Edward I.

Men of all countries seem agreed in regarding the work of animals underground as something quite normal and commonplace. Perhaps the best instance of this was the view long held by the Ostiaks of North Siberia that the mammoths whose bodies and bones they found embedded in the frozen soil were "only" gigantic moles which worked deep down below ground, but were unlucky enough to come too near the top, and so were frozen! The facts are, however, in very strong contradiction to this view of the subterranean life of animals. Life underground and in the dark is absolutely contrary to the normal habits, tastes and structure of almost all animals except the very few, like the common moles, tuco-tuco and the marsupial sand moles, which obtain their food below the earth surface as diving birds catch fish below the sea surface. It is almost an inversion of their normal way of life, and is probably due, in the opinion of a writer in The Spectator, to some such compulsion as has also forced many animals to become nocturnal. Nor is it doubtful that, if once this necessity were removed, their tendency would be to abandon this unnatural life and return to the regions of light.

How strong the pressure must have been which forced them underground may be gathered from the list of English terrestrial mammals. Twelve of these are bats, but of the remaining twenty-nine, no less than sixteen, or more than half, live either wholly or partly underground. The list includes the fox, three shrews, the mole, the badger, the otter, three species of mice, two rats, three voles and the rabbit. Besides, there are several species of birds, as widely different in habit as the stormy petrels, sand martins, puffins, sheldrake ducks and the kingfisher, which for a time live in holes excavated in the earth. To abandon the sun, to bask in whose rays is to most animals one of the most agreeable of physical enjoyments, is an almost greater sacrifice than the relinquishment of fresh air. Yet the sacrifice is made, and the creatures, though not without occasional suffering and loss of health directly attributable to this cause, have succeeded in adapting themselves with great success to the new conditions. It might well be that the measure of this success decreased in proportion to the completeness with which the different species have adopted the underground habit and abandoned light and air. But in normal conditions this is not the case. The fox, which we take to be the last of English mammals to become a burrower and dweller in holes—largely owing to the increase of fox hunting and multiplication of packs of hounds—is an animal which spends as little time there as it can help, and has never ceased to suffer in health from the change. The earth becomes tainted, the foxes contract mange, and the spread of this fatal disease has increased yearly as they have become more subterranean, and by taking their food into the holes have converted them into larders as well as sleeping places.

How most of the burrowing animals find life endurable at all is difficult to discover. No one who has seen colliers coming for their lamps and about to descend into the pit can have failed to note the marks of physical strain exhibited by all—from old men to boys. As each man or lad comes up and shouts the number of his lamp, the harsh, loud voices, the overwrought lines of the face, and the general air of tension show that, however well satisfied the pitman is with his calling, he at least is not yet adapted to the underground life. But burrowing animals are among the merriest of the merry; there are few creatures more full of gayety and buoyant spirits than a prairie dog, or even a sandhill rabbit; and we have only once seen an animal grimy from attempted burrowing, and that was an opossum which mistook a chimney for a hole in a hollow tree. Some have coats so close and fine that sand runs off them like water does from feathers, others have "shivering muscles," by which they can shake their jackets without taking them off. Rats, however, do object to some forms of dust, and will not burrow in it. An old Suffolk rat catcher always laid ashes in the runs made by them beneath brick floors. His theory on the subject was that the ashes "fared to make them snuffle."

But even if earth, dust and clay do not adhere to the animals' coats when burrowing, the danger, or at least the discomfort, to the delicate surface of the eye would seem to afford an almost constant source of uneasiness to creatures burrowing in loose soil. But the eyes of most burrowing creatures are by no means protected against such damage. If the rat and the rabbit had a horn plate over their eyes, as a snake has, or overhanging eyebrows and deeply sunk orbits, the modification would be at once explained by evolution; but they exhibit no such modification whatever. On the contrary, both of them have prominent, rather staring eyes, without protection, and no eyelashes to speak of. We believe that, just as divers learn to keep their eyes open under water without feeling pain, so many of the mining animals can endure the presence of dust and grit on the eye without discomfort. Tame rats will allow dust or fine sand to rest on the eyeball without trying to remove it; and it may be inferred that rabbits, mice, voles and shrews can do the same. The mole's eyes have become so atrophied that when a mole is skinned the eyes come off with the skin; but this is probably not because the mining hurts the eye, but because the mole, having learned to work by scent and touch, had little further use for sight.

Ventilation, or rather the want of it, must be another difficulty in the underground life of almost all mammals. The rabbit and the rat secure a current of air by forming a bolthole in connection with their system of passages; but the fox, the badger and many of the field voles and mice seem indifferent to any such precaution. There is no doubt that, whatever gave the first impulse to burrow, many animals look upon this to us most unpleasant exertion as a form of actual amusement. It also confers a right of property. Prairie dogs constantly set to work to dig holes merely for the love of the thing. If they cannot have a suitable place to exercise their talent in, they will gnaw into boxes or chests of drawers, and there burrow, to the great detriment of the clothes therein contained. In an inclosed prairie dog "town" they have been known to mine until the superincumbent earth collapsed and buried the greater number. A young prairie dog let loose in a small gravel-floored house instantly dug a hole large enough to sit in, turned round in it, and bit the first person who attempted to touch him. Property gave him courage, for before he had been as meek as a mouse.

It is noticeable that the two weakest and least numerous of our mice, the dormouse and the harvest mouse, do not burrow, but make nests; and that these do not multiply or maintain their numbers like the burrowing mice and voles. But the fact that there are members of very closely allied species, some of which do burrow, while others do not, seems to indicate that the habit is an acquired one. In this connection it is worth noting that many animals which do not burrow at other times form burrows in which to conceal and protect their young, or, if they do burrow, make a different kind of a more elaborate character. Among these nursery burrows are those of the dog, the fox, the sand martin, the kingfisher and the sheldrake. Foxhound litters never do so well as when the mother is allowed to make a burrow on the sunny side of a straw stack. In time she will work this five feet or six feet into the stack, and keep the puppies at the far end, while she lies in the entrance. Vixens either dig or appropriate a clean burrow for their cubs, which is a natural habit, or, at any rate, one acquired previously to the use of earths by adult foxes.

The sand martins are, however, the most complete examples of creatures which have taken to underground life entirely to protect their young, and abandon it with joy the instant these have flown. How far the kingfisher and the sheldrake contribute to the making of the burrows in which they lay their eggs is doubtful, but it is a very notable change of habit in birds of such strong flight and open air, active habits. It may be paralleled by the case of the stormy petrels and forktailed petrels, true ocean birds, which, nevertheless, abandon the sea and air to dig deep holes in the soil of the Hebridean islets, and rear their young in these dark and tortuous passages. Rabbits, rats and some other rodents make a nursery burrow of a very rudimentary kind, having only one opening which the mothers close up when leaving the nest. This probably gives the clew to the process by which the true "underground animals" have been evolved. First they scratched holes in which to shelter their young. Then they made use of the same device to protect themselves, and acquired much greater skill in working, and some modifications of coats and claws to do this with comfort and effect. In time the habit became so easy that its exercise afforded them pleasure; and thus we have the spectacle of the prairie dog who digs holes for amusement.

MIMICRY IN INSECTS.*

SHARING in the perplexity avowedly felt by many of my predecessors in this chair as to the choice of a subject for the annual address—perplexity arising rather from the redundancy than from the scarcity of entomological matter—I have been led to think, considering the wide-reaching importance of the questions involved and the unmistakable interest shown in the recent discussion at two of our meetings, that some account of the mimetic relations existing among insects might not be out of place. Having for a considerable period devoted some attention to the matter, I propose to pass in review what has been placed on record; and if, in so doing, I traverse ground very familiar to most of us, my excuse must be the fascinating interest which attaches to the whole subject.

EARLY CONTRIBUTIONS TO MIMICRY.

The application by Henry Walter Bates, our lamented president, of the great principle of natural selection in elucidation of the mimicries found among insects is too well known to require any detailed repetition here. It is sufficient to recall that, as the result of many years' experience in tropical South America, Bates established the facts that (1) among the abundant and conspicuous butterflies of the groups Danainæ, Heliconiinæ, Acræinæ, and some Papilioninæ were found very much rarer mimicking forms, chiefly of the group Pierinæ, but partly belonging to other groups and some even to the Heterocera, which, departing very widely from the aspect of their respective allies, imitated with more or less exactness the abundant species in question; (2) the numerous and showy Danainæ, etc., although of slow flight, did not appear to be molested by the usual insectivorous foes; and (3) the members of these unassailed tribes possessed malodorous juices not found in the mimicking forms or their allies. From these data he argued that the explanation of these extraordinary resemblances was to be found in the great advantage it would be to species undefended by offensive secretions, and therefore palatable and much hunted down, to find escape in the disguise of species recognized and avoided as unpalatable; and traced the mimicries to the long-continued action of natural selection, perpetually weeding out by insectivorous agencies every occurring variation not in the direction of likeness to the protected forms, but as perpetually preserving, and so aiding the development by heredity of, every variation favorable to the attainment of the protective mimicry.

This sagacious application of the Darwinian theory in solution of one of the most difficult and baffling of the problems presented to zoologists was of the greatest service and encouragement to all students of evolution. I retain to-day the liveliest recollection of the delight I experienced in the perusal of a copy of Bates' memoir received from himself; for his work was not that of the mere cabinet systematist, but came with all the force of face to face commune with the abounding life of the tropics.

Before two years had passed, Bates' explanation of mimicry was confirmed by his former companion in exploration, Alfred Russel Wallace, who, working with equal devotion in the Malayan Islands, had observed and was able to adduce a strictly analogous series of mimetic resemblances among Oriental butterflies, and gave his unreserved acceptance of the Batesian interpretation. Such support from the cofounder with Darwin of the theory of natural selection, and from a naturalist of the widest experience in both western and eastern tropics, was of the greatest weight with evolutionists generally.

My own contribution to the subject was read to the Linnean Society in March, 1868. In the previous year I had made an entomological tour in Natal, and had enjoyed some precious opportunities of observing in nature several cases of mimicry between species not inhabiting the Cape Colony. There was no claim to originality in my paper; it simply rounded off the case by adding from Africa, the third great tropical region of the globe, a series of instances and observed facts confirmatory of those brought forward by Bates from the Neotropical, and by Wallace from the Oriental region. Of course I had had nothing like the extended field experiences of those great naturalists, and the African material then available was but scanty; but it so happened that perhaps the most striking and elaborate of all recorded cases of mimicry—that exhibited by the females of the Merope group of Papilio—had come under my personal observation in South Africa, and I was thus in a position to describe satisfactorily a wonderful illustration of the Batesian theory.*

It will be remembered that Bates, in his memorable paper, also brought to notice the very close resemblances, or apparent mimicries, which unquestionably exist between species belonging to different groups or subfamilies of protected distasteful butterflies themselves; but neither he nor Wallace felt able to give any explanation of these instances, which obviously differed very materially from the cases of mimicry of an unpalatable protected species by a palatable unprotected one. Not until 1879 was there any elucidation of this side of the matter, but in May of that year appeared in Kosmos Fritz Müller's notable paper on "Ituna and Thyridia," which was translated by Prof. Meldola, and printed in our Proceedings for the same year (p. xx). In this memoir Müller made the valuable suggestion that the advantage derivable from these resemblances between protected forms was the division between two species of the percentage of victims to the inexperience of young insectivorous enemies which every separate species, however well protected by distastefulness, must pay.

Prof. Meldola not only brought forward and supported, with all his wonted grasp and acumen, F. Müller's daring interpretation of this phenomenon, but in 1882, in a paper discussing the objections brought against Müller's view, made a distinct advance by showing how that view could justly be extended to explain the characteristic and peculiar prevalence of one type of coloring and marking throughout large numbers of species in protected groups—so especially noticeable in the subfamilies Danainæ, Heliconiinæ and Acræinæ.

In 1887 was published Prof. Poulton's most interesting memoir entitled "The Experimental Proof of the Protective Value of Colors and Markings in Insects in Reference to their Vertebrate Enemies," which dealt in great detail with the actual results of numerous experiments conducted by himself and other naturalists with the object of ascertaining to what extent highly conspicuous (almost always distasteful) larvæ and perfect insects are rejected or eaten by birds, lizards and frogs. The conclusions given at the close of this paper cover a wide range in connection with the subject of warning coloration, and among them I would call special attention to No. 5, in which the author points out that "In the various species in which a conspicuous appearance is produced by color and marking, the same colors and patterns appear again and again repeated," and adds that "In this way the vertebrate enemies are only compelled to learn a few types of appearance, and the types themselves are of a kind which such enemies most easily learn." This generalization certainly had the merit of first detecting a great additional advantage derivable from the common aspect exhibited by a number of protected forms in the extended "Müllerian" associations indicated by Prof. Meldola; and it was applied by Wallace to the case of the Heliconiidæ in the comprehensive survey of warning coloration and mimicry generally given in "Darwinism." We are further indebted to Prof. Poulton for the discussion and summary of all extant data up to 1890 in his "Colors of Animals"—a work which abounds in pregnant suggestion, and indicates with justice and clearness how far the evidence forthcoming was valid, and in what directions evidence still lacking should be sought.

Wallace well observed that "to set forth adequately the varied and surprising facts of mimicry would need a large and copiously illustrated volume; and no more interesting subject could be taken up by a naturalist who has access to our great collections and can devote the necessary time to search out the many examples of mimicry that lie hidden in our museums." A work ostensibly of this character was issued in 1892–93, in two parts, from the pen of the late Dr. Erich Haase, under the title of "Untersuchungen über die Mimicry auf Grundlage eines natürlichen Systems der Papilioniden;" and last year an English translation of the second part was published, and has quite recently been reviewed by Prof. Poulton (Nature, November 4 and 11, 1897).

RECENT CONTRIBUTIONS TO THE SUBJECT.

Among recent contributions to the subject, we shall, I think, all agree in assigning a high place to the memoirs with which Dr. F. A. Dixey has enriched our Transactions. In 1894 he read before the Society his elaborate paper "On the Phylogeny of the Pierinæ, as Illustrated by their Wing Markings and Geographical Distribution," and took occasion to discuss the wide divergence from the primitive or typical pattern of the group caused by mimicry in such genera as Euterpe, Pereute, Dismorphia, etc. Adopting the Müllerian

*Abstract of the presidential address delivered before the Entomological Society of London on January 19, by Mr. Roland Trimen, F.R.S. From Nature.

* At various subsequent dates I was enabled, through the valuable aid of Mr. J. P. Mansel Weale and Colonel J. H. Bowker, to make known to science conclusive evidence of the species identity of the three mimetic females of Papilio cenea, and of the pairing of the widely differing sexes of that species.

interpretation as expanded by Meldola, he proceeded to offer the original suggestion that, in the acquisition of closer resemblance between two or more protected forms, it was not necessary that in every instance the process of adaptation should lie solely in the imitation of one particular form as model, but that there might very well exist mutual convergence of the forms concerned, thus accelerating the attainment of the common beneficial resemblance. This "reciprocal mimicry" the author further explained in a paper read in 1896 "On the Relation of Mimetic Patterns to the Original Form" (pp. 72-75), by a consideration of certain mimetic sets of Heliconii, Pierinæ and Papilioninæ which present features and relations of pattern and coloring explicable apparently in no other way than by the hypothesis in question. This paper also gave a lucid demonstration, traced through corresponding series of existing forms of both mimetic and non-mimetic Pierinæ, of "the successive steps through which a complicated and practically perfect mimetic pattern could be evolved in simple and easy stages from a form presenting merely the ordinary aspect of its own genus," and further adduced reasons for holding that "it is not necessary that the forms between which mimicry originates should possess considerable initial resemblance." In his latest memoir, "Mimetic Attraction," read on May 5 last, Dr. Dixey expanded a suggestion he had previously (1896) made respecting divergent members of an inedible group to point out—still from evidence in the Pierine subfamily to which he has devoted so much fruitful study—"how the process of gradual assimilation starting from one given point may take not one direction only but several divergent paths at the same time," with the result that a more or less intimate mimetic relation was brought about with several protected forms of quite different affinities, though each connected in their coloring and aspect with some group of distasteful associates. He further set forth very fully the distinction which exists between the mimicry of inedible by edible forms, which could only be in one direction and was of advantage to the mimicker alone, and the assimilation among inedible forms themselves, where the mimetic attraction acts reciprocally, to the advantage of all participators.

Another of our fellows, Colonel C. Swinhoe, distinguished for his wide and intimate knowledge of Oriental Lepidoptera, read before the Linnean Society, in 1895, a most interesting paper "On Mimicry in Butterflies of the Genus Hypolimnas." In this memoir, as the author points out, a small group of wide-ranging mimetic insects is followed throughout its geographical distribution, and the process of mimetic modification is traced through the female, from the amazing instability of that sex of H. bolina (local form) in the Fiji Islands, where the male is stable and of the normal ancestral pattern and coloring, to the opposite extreme in Africa, where (with the exception of H. misippus) both sexes of the known allied forms of the genus are equally mimetic.* The singular contrast between the numerous modifications of the female of the Bolina type and the absolutely constant imitation of Danais chrysippus alone by the ♀ H. misippus is well brought out, and the different courses thus pursued by the respective females are shown to depend on the range, variation and abundance of the model that is mimicked. Colonel Swinhoe had previously (1887) published a good account of mimicry in Indian butterflies, and in it made special reference to the remarkable series of close likenesses between species belonging to different subgenera of the great protected genus Euploea.

MIMICRY IN VARIOUS ORDERS OF INSECTS.

So much prominence has naturally been given to the very conspicuous development of mimicry among the Lepidoptera that it is not uncommon to hear the matter spoken of as if limited to butterflies and moths, and even entomologists need to be reminded of the prevalence of the phenomenon among other orders of insects. The stinging Hymenoptera furnish the most numerous models to members of other orders, being closely mimicked by numerous Diptera, by many heterocerous Lepidoptera, by various Carabid, Heteromerous and Longicorn Coleoptera, and by some Hemiptera; while certain ants are well imitated by spiders. As regards Coleoptera, mimicry is mainly found within the limits of the order itself—e. g., Cicindelids by Heteromera and Longicorns, Carabids by Heteromera, Malacoderms by Longicorns, and Rhynchophora by Longicorns; but certain Cicindelid and Rynchophorous beetles are closely copied by Orthoptera, belonging respectively to the genera Condylodeira and Scepastus. Lepidoptera do not seem to find mimickers beyond their own order, unless the case quoted by Haase from E. Hartert, of the resemblance of a large cicada to the Indian Thaumantis aliris (Morphinæ) be one of actual mimicry. Nor do Diptera appear to be models for imitation, except in the case of the hunting spiders, which mimic the Muscidæ they chase; although the neuropterous Bittacus certainly bears a strong likeness to Tipula, and may possibly find the advantage of that harmless aspect in approaching its prey. It cannot be denied that some of the interordinal mimicries are even more impressive and striking than those so notable among butterflies, the excellence of the superficial disguise of general outline, proportion of parts, coloring and markings being so great as to throw into obscurity the really vast structural discrepancies. Such cases as the imitation of the South American wasps of the genera Polybia and Synoeca by moths of the genera Sphecosoma and Myrmecopsis, of the Bornean sand wasp Mygnimia aviculus, by the beetle Colobothombus fasciatipennis,† or of the Philippine tiger beetle Tricondyla, by the cricket Condylodeira, are absolute marvels of deception, all belonging to that special phase of mimicry where the obvious advantage to the unarmed mimic lies in being mistaken for the armed and formidable model.

Returning to the general aspects of the subject, it is of importance to consider more closely how the evidence stands in relation to (a) persecution by insectivorous foes, (b) possession of malodorous and distasteful juices by certain groups of insects, (c) rejection or avoidance by foes of the insects provided with offensive juices, and (d) loss occasioned to distasteful species by the attacks of young and inexperienced enemies; for it is admittedly on the co-operation of these factors that the theory of mimicry depends.

(a) PERSECUTION BY INSECTIVOROUS FOES.

As regards the first point, the broad fact of insects generally constituting the food of countless devourers, vertebrate and invertebrate, is beyond dispute; immense and incessant persecution is universally at work. But when we proceed to examine this world-wide persecution more in detail, and to ask in what special directions it works, or what groups or species are the particular prey of certain groups or species of enemies, we very soon discover how little is exactly known. Birds, for instance, are such notorious and apparently indiscriminate insect eaters, and some of them are so active and demonstrative in their hunting, that it seems but reasonable to regard them as the chief pursuers on the wing of the abundant and defenseless butterflies. Yet in the discussion which followed the reading of Dr. Dixey's last paper already referred to nothing was more noticeable than the very scanty testimony to such persecution on the part of birds that could be brought forward by the very competent well-traveled entomologists present. In fact, the poverty of observed cases of such attack has induced the opinion among some entomologists that birds very rarely chase butterflies at all, and the published expression of this view by Pryer, Skertchley, Piepers and other experienced collectors cannot be overlooked. But I am persuaded that in this instance, as in so many others where the life history of animals is concerned, the dearth of evidence is due to the neglect of well directed and sustained observation. Little can be gained by merely noting such cases as happen to force themselves on the collector's attention; the collector must resolutely set himself to search out and keep watch upon what really takes place. Considering that there is no record of any naturalist having seriously taken up the investigation of this matter in the field, I think that very much positive evidence could hardly be expected, and that what has been published goes far in the direction of proving that birds must still be reckoned among the principal enemies of butterflies.

(b) POSSESSION OF MALODOROUS AND DISTASTEFUL JUICES BY CERTAIN INSECTS.

The presence of malodorous juices in many insects is a matter of common observation, and is a protective property possessed by several entire groups, especially among the Lepidoptera and Coleoptera. There is abundant evidence as to the prevalence of these secretions, and among the Lepidoptera they are particularly developed in the butterflies of the groups Danainæ, Neotropinæ, Acræinæ, and Heliconiinæ, and also in some Papilioninæ, as well as in many moths of the groups Agaristidæ, Chalcosiidæ, Arctiidæ, Lithosiidæ, etc. The strength of the disagreeable odor emitted is in some species very great; Seitz, for instance, mentioning that the smell of the South American Heliconius besckei and Eueides aliphera extends over a radius of several paces, and Woodmason and De Nicéville testifying to the same effect as regards the Indian Papilio philoxenus and allied forms. When molested many of these offensively smelling species exude drops of a yellow or whitish fluid which leave on anything they touch a stain and odor difficult to remove, as I have experienced in the case of the Mauritian Euploea euphone, the South African Danainæ and Acræinæ, and various South African Agaristidæ, Glaucopidæ, and Arctiidæ.

The origin and manner of acquisition of these unsavory secretions have yet to be discovered; the suggestion (so much insisted on by Haase) that these juices are directly derived from those of similar quality in food plants of the larvæ arising from the long known circumstance that some of the food plants of species in the protected groups are of an acrid or poisonous character, such as (e. g.) Asclepiads in the case of many Danainæ, and Aristolochia in that of the inedible forms of Papilioninæ. No doubt, too, the fact that the unpleasant qualities are very often fully developed in the larvæ of the distasteful species—as I have found with Danais chrysippus and various Acræinæ—lends some weight to the suggestion; but at present nothing approaching sufficient data can be brought forward respecting the actual food plants to which the protected groups, in contrast to the unprotected, are thought to be restricted. It cannot be gainsaid, as Prof. Poulton has pointed out (Proc. Zool. Soc. Lond., 1887, pp. 198, etc., and Nature, November 4, 1897, p. 3), that the food plants of many of the distasteful European moths do not belong to any poisonous or acrid category; and his own and Mr. Latter's papers on Dicranura vinula alone amply demonstrate what powerful acids can be elaborated by a larva which finds its food in such innocuous plants as poplar and willow. The supposed direct derivation of the nauseous juices from the plants consumed is thus plainly a matter that awaits investigation from both biological and chemical standpoints.

(c) AVOIDANCE OR REJECTION OF INSECTS BY INSECTIVOROUS ANIMALS.

The avoidance or rejection as food by insectivorous animals of the insects possessing malodorous or distasteful juices no longer rests merely on the negative evidence given by Bates, Wallace, Belt, and other competent observers, to the effect that in nature such distasteful forms are habitually neglected and unmolested; there is now much positive experimental evidence as to the manifest avoidance or disgust with which such species are left untouched, or thrown aside after tasting, when offered to domesticated or captive vertebrate animals that devour ordinary insects with avidity. The numerous experiments of this kind recorded by Butler, Jenner, Weir, Weismann, Poulton, and Lloyd-Morgan, as regards both larvæ and imagos of European species, are supported by a few made by Belt with Heliconiinæ in Central America, by D'Urban and myself with Danainæ and Acræinæ in South Africa, and by Haase with Danainæ in Singapore.

It is manifest, of course, that even the most distasteful forms cannot enjoy complete immunity from persecution; in ordinary circumstances they are doubtless mainly kept down by parasitic insects, and during any scarcity of more palatable prey it is certain that they will be devoured faute de mieux by vertebrates and invertebrates alike.

(d) LOSSES DUE TO INEXPERIENCE OF ENEMIES.

As regards the important point whether the protected forms have to suffer a certain percentage of loss from the attacks of young and inexperienced birds and other animals, it must be admitted that the evidence at present forthcoming is exceedingly scanty; and I have long felt considerable doubt as to the sufficiency of this factor to account for the mimetic resemblances, often remarkably close, between members of associated protective groups. But on reviewing carefully the recorded observations which appear to bear on the question, I have found reason to think there is enough support to justify the provisional acceptance of the Müllerian explanation. We have in the first place Fritz Müller's own capture of Heliconii and Acræinæ with a notched piece bitten out of the wings, and Distant's (l. c., p. 65) of a Danais chrysippus whose wings had been bitten unsymmetrically, apparently by a bird. Then there is the significant record of Skertchley, who, among twenty-three species of Bornean butterflies taken with both hindwings mutilated in the same manner, notes no less than four Danainæ, viz., Hestia lynceus, H. leuconoe, Ideopsis daos and Euploea midamus. Moreover, it is very remarkable that several of those entomologists who have specially emphasized the small part played by birds in attacking butterflies mention, among the few cases of such attack as they witnessed, instances of protected forms being assailed, Sir G. Hampson remarking that in South India the Euploeæ and Danaids were caught as often as any others, and M. Piepers that in two of the four cases which he had seen in Sumatra and Java, the species seized were Euploeæ.

The question underlying this is manifestly whether insect-eating animals have an instinctive inherited discernment of what species are unfit for food or whether, on the contrary, each individual has to acquire this necessary knowledge by personal experience, aided in some vertebrate groups by parental guidance. So numerous and so marvelous are the instinctive or congenital activities of animals—especially in the insect world, where past experience or parental instruction is almost always non-existent—that there has been a very general disposition on the part of naturalists to incline to the former view in a matter so all-important as suitable food. Yet, as far as experiment has hitherto gone in this direction, there seems good ground for holding that—at any rate in such specially insectivorous vertebrate groups as birds, lizards and frogs—the young possess no such hereditary faculty of discrimination, but have to discover individually what to avoid. This appears not only from Mr. Jenner Weir's and especially Prof. Poulton's careful and often-repeated experiments with lizards and frogs, but also from Prof. Lloyd-Morgan's study of newly hatched birds of different orders, which indicates clearly with what complete want of discrimination every object of suitable size is at first pecked at and tasted, but how soon experience tells and is acted upon. Prof. Lloyd-Morgan made special trial of these young birds with many distasteful insects and their larvæ, and states in conclusion that he did not find a single instance of instinctive avoidance, but that the result of his observations is that "in the absence of parental guidance, the young birds have to learn for themselves what is good to eat and what is distasteful, and have no instinctive aversions."

In concluding what I feel to be a very incomplete outline of what has been done in this most important branch of zoological research, I cannot refrain from expressing the gratification I find in noting how by far the chief part in the investigations pursued and in the deductions derived from them has from the outset been borne by fellows of this society. It is work on which we may with justice be congratulated, and which should encourage perseverance in the same and kindred lines of inquiry.

NEED OF OBSERVATIONS OF LIVING ORGANISMS.

Here, as in many other biological researches, it cannot be too strongly insisted on that no result of lasting value can be hoped for without resort to the living animals among all the natural conditions and surroundings. It was not a stay-at-home theorist, familiar only with the dried specimens of the cabinet, that detected the meaning of mimicry and gave to science a rational explanation of the mystery, but an ardent explorer and naturalist, who devoted many of the best years of his life to field work in tropical lands. I am the last to undervalue the knowledge of the systematist, which is absolutely indispensable to all intelligible record, and I fully recognize that no naturalist can be properly equipped for his work without a fair amount of systematic training; but philosophical discovery in any direction such as we are now considering can never be truly advanced without unflagging observation and experiment among organisms living in their natural environment. How but by the closest and most exact attention to the entire life history of animals in their native haunts can we expect to deal satisfactorily with such questions as this of mimicry, of protective resemblances generally, of seasonal dimorphism, sexual selection, local variation and the like? Admitting gratefully the good work of this kind which has been carried on in Europe, and especially in our own country, one cannot but regret that from tropical regions, where alone the abundance, complexity and incessant activity of life afford full prospect of the adequate reward of such research, we have little more than isolated notes and unconnected and incomplete observations, mere indications—precious as they are—of the rich harvest that lies unreaped for lack of resident workers devoted to the task.

It is on this account that I earnestly renew the plea put forward from this chair on May 5 last, for the establishment, in tropical countries, of biological stations for the study of the terrestrial fauna; where, as in the existing marine biological stations, naturalists could follow, during a succession of seasons, special lines of observation and experiment under favorable conditions of laboratory and other equipment, free from the hindrances and distraction of ordinary collecting travel and with all the advantages of mutual help and encour-

* It should be noted that in the African H. salmacis and the Malagasy H. dexithea the sexes are alike and non-mimetic, and that therefore these species probably most closely approximate to the primitive appearance of the genus.

† See Pryer, Trans. Ent. Soc., 1885, p. 309, pl. x., who in the same place also figures another most striking case from Borneo, in which the hymenopterous Triscolia patricialis is mimicked by the lepidopterous Scoliomorpha insignis.

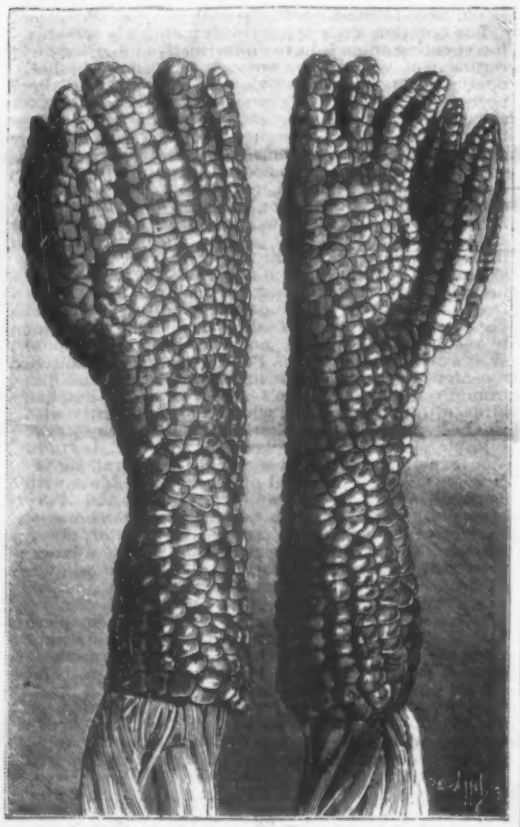
agement. The living expenses, for men of the simple tastes of the naturalist, would not be great; and I feel certain that, with the increasing facilities for swift transport, it would not be long before many students of biology would embrace the opportunity so provided for the effectual prosecution of researches of the utmost value to science.

A VEGETABLE CURIOSITY.

PLANT curiosities in the way of fruits and vegetables that assume the most extraordinary forms are very numerous. We have already had occasion to mention several examples of such teratological departures from the normal type, and of these we need mention only the hand-shaped carrot which we not long ago figured and described.

We reproduce herewith, from La Nature, another case of malformation in a plant, the vegetable concerned this time being an ear of corn which through fission has assumed the form of a human hand with all the fingers separate and distinct. The figure gives a view of two sides of the ear, in one of which may be seen the hollow of the hand and in the other the thumb and four fingers. The illusion is complete and even the respective dimensions of the fingers are observed in a certain measure. The four fingers seem to unite upon the same line so as to well figure the flat of the hand. The back of the hand also is well outlined. Let us add that, to complete the illusion, the lower part of the ear forms a pretty well defined wrist. All the parts are provided regularly with kernels of corn, and the latter seem to be so grouped as in nowise to alter the appearance of a hand.

In America, where corn was found in cultivation by the Indians at the advent of the whites, this fission of



EAR OF CORN SIMULATING A HUMAN HAND.

the ears is often observed, and the occasional assumption of the form of a human hand like that described by our contemporary seems to have attracted the attention of the natives; for in the dictionary of Father Rasle, who labored among the Abnakis on the Kennebec over two hundred years ago, we find among the Indian names of the different varieties of corn that of uretsimin, or "hand corn," or, literally, "hand grain," grain being put by synecdoche for the entire ear. Although the different varieties of corn were placed by these Indians among inanimate objects, this hand-shaped "sport" was raised to the dignity of animate, that is to say, the name by which it was called was treated grammatically as if the object that bore it were a living being.

We learn from a railroad contemporary that a new profession has sprung up on this side of the Atlantic. The profession seems to depend for its existence upon faulty maintenance of railway stations, thereby enabling the professor to temporarily disable himself and sue the company for damages. The Street Railway Review gives the following account of a professional contortionist who has chosen for a vocation the dislocating of his hip joint when the circumstances are favorable to securing a verdict for damages against a railroad company. Some months ago a man fell on the platform of a passenger station near Indianapolis, having caught his heel in a crack, and the result was a dislocated hip. The company settled for $2,200 and attorney's fees, and extended courtesies in the way of furnishing transportation for the man and his nurse, etc. Quite recently a similar accident occurred in Virginia, and a claim of damages presented. The man had been seen the day before hunting about the platform for a hole in which to catch his heel, and a traveler who was present recognized him as the victim of the "accident" in Indiana. The Virginia road did not settle his claim, and the Indianapolis company want his present address.

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